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PAPERS AND PROCEEDINGS OF THE ANNUAL MEETING

OF THE AMERICAN MOSQUITO CONTROL ASSOCIATION HELD JOINTLY WITH THE ANNUAL MEETING OF THE FLORIDA ANTI-MOSQUITO ASSOCIATION DAYTONA BEACH, APRIL 12–17, 1953

PART 2

FURTHER OBSERVATIONS ON THE USE OF GRANULAR DUSTS

ROBERT L. VANNOTE

Secretary, Morris County Mosquito Extermination Commission, Morris Plains, N. J.

At our annual convention in Salt Lake City I had the pleasure of reporting on the application of 10% DDT granular dust as prepared by the Tobacco By-Products and Chemical Corporation of Richmond, Virginia, as a prehatch control for the fresh water flood mosquito, *Aedes vexans*.

Our thoughts in this direction date back to 1946. The 20,000 acres of flood-plain in the Upper Passaic River Valley have long presented a problem in mosquito control. Ground treatment of the floodwaters was found to be prohibitive due to the soft nature of the meadows and the barriers of brush and woods making the maneuvering of mechanical equipment difficult. The same situation held true for the aircraft application of standard mesh dusts or liquid insecticides as the umbrella of trees and prevailing winds made such applications costly and generally ineffective.

At the suggestion of Dr. Bailey B. Pepper, Head of the Department of Entomology of the N. J. Agricultural Experiment Station of Rutgers University, the coarse dusts were experimentally used in 1950 and 1951. The success of this work pointed to the standardization of the 30–50 mesh screen tobacco stem dust as a carrier for DDT.

In May of 1951, in cooperation with the Essex County Mosquito Extermination Commission, some 900 acres were treated as a prehatch control while the meadow surfaces were dry. Subsequent rains and floods during the season hatched mosquito eggs; however, the larvae soon died.

The only important observation to be made on the 1951 work that was not reported last year is the carry-over of results into the 1952 season.

Due to budget restrictions no applications were made in 1952 so the carry-over effectiveness of the 1951 application was of real interest.

Observations made by qualified personnel indicate that the usual spring brood was held in some 75% control and it was not until mid July that no effects were observed.

In the discussion of coarse dusts it would seem wise first to determine whether the immediate release of the insecticide from the granules is desirable or whether a long, gradual release would be most effective. Our experience in dealing with flood-water mosquito problems would indicate the latter to be more effective and economical therefore resulting on our standardization of the tobacco stem carrier rather than the clay pellets.

GRANULAR CLAY LARVICIDES FOR THE CONTROL OF SALT MARSH MOSQUITOES

J. A. BERTHOLF
Director, Broward County Anti Mosquito District, Ft. Lauderdale, Fla.

In Broward County salt marsh mosquitoes have attained a resistance to the conventional insecticides that no longer permits adequate control through space spray adulticiding using concentrations that can be tolerated in residential areas. We are therefore confronted with the necessity of devising a more completely effective program of larviciding for these species.

The extent of our salt marsh is small in comparison with many of the other coastal counties of Florida but it is completely and immediately surrounded with residential development. The average flight of the mosquitoes it produces is less than one-half mile to bring their annoyance to some thirty thousand of our citizens. Under these conditions a larviciding program that is much less than one hundred percent effective cannot be considered.

At least seventy-five percent of the areas in the District that produce salt marsh mosquitoes are not accessible to ground operated larviciding equipment and can be effectively treated only from the air. We have demonstrated in these areas that a reasonably uniform distribution of one-tenth of a pound of the gamma isomer of BHC per acre, if it reaches the surface of the breeding water, will result in a complete kill of larvae within four hours. While pupae may withstand this dosage, we find that the resultant adults die upon emergence.

About half of our breeding areas that can be reached only from the air lie fairly open and can be completely controlled by the plane dispersal of liquid sprays. The balance, however, lie under a cover of white mangrove, sea oxeye, salt marsh, bermuda or other growth ranging from light to very dense. In these areas the amount of liquid insecticide that reaches the breeding water may range from fifty percent to none at all and the resultant kill of larvae is in direct proportion.

The District has experimented since 1950 with materials that might prove acceptable as vehicles for plane dispersed larvicides in these covered areas. With the very important help of Professor Whitehead of the University of Arkansas, Mr. W. C. McDuffie and Mr. J. C. Keller of the Orlando Laboratory of the Bureau of Entomology and Plant Quarantine, and the California Spray Chemical Company, we are now being supplied by Cal-Spray with a granulated clay product that we have been using since September 1952.

Our initial success in doing a job effectively that had been the main stumbling block to our past larviciding operations, leads us to offer this information to our associated Districts in the hope that they may, by experimenting with it also, aid in the development of cheaper materials and more economical methods of dispersal. The present product too, produced in small quantities on order, could probably be reduced in price if a considerable market could be provided. Having demonstrated over many years the limitations of drainage and tidal flushing programs and realizing that the reclamation of the thousands of acres of existing salt marshes on our most desirable tourist areas will have to be a long range project, chemical larviciding is still the most important weapon that can presently be used in many of our Districts. Such control of salt marsh mosquitoes as has been achieved in Florida has been the result of the work of many agencies who have found a common forum for the discussion of their successes and failures in the meetings of the Florida Anti-Mosquito Association. We feel that this small step in actual large scale use of

a penetrating insecticide can be developed, by the directors of the Florida districts, into a tool that will be of great value to all of us.

MOSQUITOES AND THEIR CONTROL IN PRINCE EDWARD ISLAND [1]

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INTRODUCTION. Prince Edward Island is the smallest of the Canadian provinces, with an area of 2,184 sq. mi. and a population of about 100,000. Situated in the Gulf of St. Lawrence, it is a gently rolling lowland country with no part far from the sea. Its soil is characteristically red sandy loam, with underlying rock formations principally of red sandstone and red clay shale. A large part of the Island is devoted to diversified farming, but numerous farm woodlots and patches of woodland, scattered trees, and tree-lined roads give it a park-like appearance. Its short, deep rivers are subject to the ebb and flow of the tide. Along its coasts are sand dunes and long stretches of fine sand beaches, especially along the north shore. The surrounding sea has a moderating influence on the climate, and mean monthly temperatures range from 15.5° F. in February to 78.8° F. in August. Precipitation is rather uniformly distributed throughout the year and averages about 43 in., of which 11.6 in. is in the form of snow (5).

In June, 1952, I investigated a mosquito nuisance reported in and near Prince Edward Island National Park. This park extends along the north shore of the Province for nearly 25 mi., from Tracadie Bay on the east to New London Bay on the west, but contains an area of only about 7 sq. mi. It is made up of three main sections, each bordering the seashore, and known, from east to west, as the Dalvay-Stanhope section, the Brackley Beach section, and the Cavendish or Green Gables section. The mosquito problem in the area was summarized as follows by the Secretary of the P.E.I. Innkeepers' Association (in litt., March 3, 1952): "Our beaches are outstanding and safe, the temperature of the water ideal, we have some nice playgrounds, but on certain days no one can enjoy any of those facilities on account of the mosquitoes. At times they are not annoying, at others they are simply awful, obliging people either to remain indoors or to leave the district. The worst places are around Brackley, Stanhope and Dalvay. In 1951 there were many mosquitoes in June and July, then they all came back during the end of August and September."

MOSQUITO SPECIES. Up to 1940, only 2 species of mosquitoes had been identified from Prince Edward Island. In May, 1940, I collected larvae in and near the National Park representing an additional 9 species. In June, 1952, 11 species were collected, of which 4 are new records for the Province, bringing the total of species recorded to 15. The associations of the species collected in the larval stage in 1952 are shown in Table 2.

Comments of park officials, residents, and visitors confirmed that mosquitoes are

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TABLE 1.—Mosquitoes collected in Prince Edward Island

Species	Favorite larval habitat	Year Collected		
		1940	1952	Other
Aedes cantator (Coq.)	Salt marshes	X	X	
" *sollicitans* (Wlk.)	" "		X	
" *vexans* (Mgn.)	Rainpools, ditches, etc.		X	X
" *excrucians* (Wlk.)	Transient pools in woods, meadows	X	X	
" *fitchii* (F. & Y.)	" " " " "	X	X	
" *stimulans* (Wlk.)	" " " " "	X		
" *canadensis* (Theo.)	Temporary woodland pools		X	
" *cinereus* (Mgn.)	" " "	X	X	
" *communis* (Deg.)	" " "	X	X	
" *implacabilis* (Wlk.)	" " "	X		
" *intrudens* (Dyar)	" " "		X	
" *punctor* (Kby.)	" " "	X	X	
" *trichurus* (Dyar)	" " "	X		
Culiseta morsitans (Theo.)	Woodland pools		X	
Mansonia perturbans (Wlk.)	Plant-grown areas of ponds, lakes			X

TABLE 2.—Species associations of mosquito larvae collected in Prince Edward Island in June, 1952

Species	*A. canadensis*	*A. cantator*	*A. cinereus*	*A. excrucians*	*A. fitchii*	*A. sollicitans*	*A. vexans*	*C. morsitans*
A. canadensis*	X		X					X
A. cantator		X	X	X	X	X		X
A. cinereus	X	X	X	X				X
A. excrucians		X	X	X	X			X
A. fitchii		X		X	X			X
A. sollicitans		X				X		
A. vexans							X	
*C.** morsitans*	X	X	X	X	X			X

* *Aedes.*
** *Culiseta.*

periodically a nuisance in certain areas from June to September. Of the species found in 1952, only three would be likely to occur in troublesome numbers throughout the season. These are the brown salt-marsh mosquito, *Aedes cantator;* the salt-marsh mosquito, *A. sollicitans;* and the rainpool mosquito, *A. vexans.* During this investigation the brown salt-marsh mosquito was the predominant species.

The brown salt-marsh mosquito and the salt-marsh mosquito are two of the famed salt-marsh mosquitoes of New Jersey. Fortunately, their breeding places and consequently their numbers are much smaller than occur in New Jersey.

White-banded Salt-marsh Mosquito *(Aedes sollicitans)*: This species had not previously been recorded north of Maine. In 1952 larvae were found in two places: in salt pools on the shore of Tracadie Harbour, and in a marsh on the north bank of the Hillsborough River, near Falconwood Hospital, northeast of Charlottetown. In both places its larvae were greatly outnumbered by those of *A. cantator.* It is probably not an important species in Prince Edward Island.

Brown Salt-marsh Mosquito *(Aedes cantator)*: This species occurs in coastal regions of Prince Edward Island, Nova Scotia, and New Brunswick and along the Atlantic coast southward to Virginia. Between June 9 and 17, larvae in various stages, pupae, and emerging adults were found in salt and brackish marshes and pools in and near P.E.I. National Park, and at several other points in Queens County. These marshes varied in size from a few to many acres. The larvae occurred alone (and in two instances with *A. sollicitans*) in water that was salt or brackish (Figs. 1 and 2). They were also found with other species in water bodies near the seashore that were apparently fresh: in pools in a shrub-grown area on Cape Stanhope, with *A. fitchii;* and in pools along the marshy margin of Long Pond (Fig. 3), near Dalvay, with *A. cinereus, A. excrucians,* and *Culiseta morsitans.* They were most abundant, however, in salt or brackish water.

A valuable source of information on the location of the breeding places of salt-marsh mosquitoes throughout Prince Edward Island is the soil maps that accompany a report of a soil survey of the Province by Whiteside (5), the salt marshes being delineated on the maps. These indicate that most of the salt marshes scattered along the coasts and bays and rivers of the Province range in size from a few to several scores of acres. However, extensive salt marshes totalling many hundreds of acres are shown on the shores of the Hillsborough River, especially near Mount Stewart. Mosquitoes were reported to be very troublesome in this area.

Rainpool Mosquito *(Aedes vexans)*: The rainpool mosquito was found on June 12 in small, shallow, grass- and sedge-grown, fresh-water pools south of the sand dunes at Brackley Point. These pools contained larvae and pupae, and adults were emerging. This species favors transient pools in the open and such places as roadside ditches and marshes. With *A. cantator,* it is an abundant pest in the Tantramar marshes in New Brunswick (4). It is a widespread and troublesome mosquito in many parts of Canada, but to what extent it is a pest in Prince Edward Island is not known. In wet seasons in Ontario several broods may emerge during the summer. Like the salt-marsh mosquitoes it may disperse considerable distances from its breeding places.

Woodland Mosquitoes (*Aedes* spp.): The other species of *Aedes* found in 1952 (Table 1) all breed in or near woods and, in general, do not move far from their breeding places. They have only one generation each year and emerge in the spring. They usually cease to be a pest by midsummer. All readily attack humans. *Culiseta morsitans,* also a woodland species, is not known to attack man. Many of the bodies of water in the National Park, especially in wooded or shrub-grown areas, were free of larvae. These may have been oiled, or the mosquitoes

FIGS. 1 and 2.—Salt marshes at Stanhope and near Brackley Beach, P.E.I., in which *Aedes cantator* (Coq.) breeds. Fig. 3.—Long Pond, near Dalvay, P.E.I.; several species were found in pools along the mar gins. FIG. 4.—Lake of Shining Waters, Cavendish, P.E.I. Numerous minnows and predacious aquatic insects prevent mosquitoes from breeding.

may already have emerged. Some of the more permanent ponds (Fig. 4) contained numerous small fish and predatory insects that would prevent mosquitoes from developing. None of these species was significantly troublesome in the neighborhood of the National Park in June. The following notes relate to the collection of the various species.

Aedes canadensis.—Pupae were taken on June 9 in pools in scrubby bush at Dalvay, and larvae and pupae were found on June 16 in an alder swamp south of Stanhope.

Aedes cinereus.—Larvae and pupae were collected on June 12 in marsh pools along the margin of Long Pond near Dalvay, and on June 16 in the alder swamp south of Stanhope. Adults emerged June 14–17.

Aedes excrucians.—Larvae were collected at Tracadie on May 20 by Mr. F. M. Cannon, of the Laboratory of Entomology, Charlottetown. On June 13–14, adults emerged from pupae taken on June 12 in pools on the marshy margin of Long Pond.

Aedes fitchii.—Larvae were collected at Tracadie on May 20 by Mr. Cannon. On June 9, larvae and pupae were found in pools near woods east of Stanhope Inn, and in shrub and grass-grown areas at Dalvay, and at Brackley Beach. Adults emerged June 13–14.

Aedes intrudens.—No larvae were found, presumably because emergence was complete. Females of this species were numerous in an alder swamp south of Stanhope, and in swampy woodland near York Station, on June 18–19.

Aedes punctor.—A few females were taken at Stanhope and York Station in mid-June.

Culiseta morsitans.—Larvae were collected between June 9 and 16 in a grassy pool at Dalvay; in mucky pools on the margin of Long Pond in the same area, and in an alder swamp south of Stanhope.

CONTROL. Control of mosquito larvae in the park area appears to have been directed mainly against the woodland species, and to have consisted largely of applying fuel oil to their breeding places. Against the adults an aerosol (5 percent DDT in kerosene) emitted from a TIFA had been employed. In general, the salt marshes apparently had escaped treatment in past seasons. It was recommended that DDT in fuel oil be substituted as a larvicide and applied at about ¼ lb. of DDT per acre by means of portable compressed air sprayers or a power sprayer mounted on a vehicle (2).

One thorough treatment of the breeding places in spring, commenced in April and completed by mid-May, should be sufficient against the woodland mosquitoes, but several treatments during a season might be necessary against the salt-marsh and rainpool mosquitoes. The first application on the salt marshes should be made by early May, and the marshes should be inspected every two or three weeks throughout the season and additional treatments applied as necessary. Temporary rainpools and flooded ditches should be examined shortly after heavy rainfalls during the summer, and sprayed as necessary. If, in spite of these measures, mosquitoes became a nuisance in an area, local relief could be obtained by the proper use of a DDT aerosol (3).

More permanent measures would include draining or filling low places where temporary pools are formed by melting snow or rain, and the cutting of ditches in salt marshes as practiced in New Jersey (1). These ditches should have sufficient laterals to permit the water in the marshes to rise and fall with the tide, so that at high tide the sea water could bring predacious fish into the deeper pools to feed on mosquito larvae, and at low tide the water in the higher, shallower parts of the marshes would be drained away.

SUMMARY. Fifteen species of mosquitoes, including 13 of *Aedes* and 1 each of *Culiseta* and *Mansonia,* are recorded from Prince Edward Island with notes on their breeding places and on the larval associations of some of them. The predominant species in June, 1952, was the brown salt-

marsh mosquito, *A. cantator* (Coq.). Control recommendations are briefly outlined.

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LABORATORY STUDIES ON THE HATCHING OF MARSH-MOSQUITO EGGS

B. V. TRAVIS [1]

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As a part of a project on the biology of salt-marsh mosquitoes in Florida, extensive laboratory studies were conducted from 1939 to 1941 to develop a method of flooding that would insure a complete hatch of mosquito eggs on soil samples collected from salt marshes for population studies (Bradley and Travis 1942, Travis and Bradley 1943). This paper reports preliminary laboratory tests with various hatching media and the effect of desiccation on the viability of the eggs. Data on the flooding of soil samples collected for egg-population studies are also summarized.

MATERIALS AND METHODS. Eggs used in the tests were laid in the laboratory by the salt-marsh mosquitoes *Aedes taeniorhynchus* (Wied.) and *sollicitans* (Wlkr.), and by one fresh-marsh species, *Psorophora confinnis* (L.-Arr.). The mosquitoes were collected in the field either from a baffle trap baited with a rabbit or from the arms of the laboratory workers.

All the mosquitoes that were engorged were transferred to lantern-globe cages for oviposition. The top of the globe was covered with gauze, on which were placed honey and raisins for food. The bottom was placed in a half petri dish lined with wet paper toweling. Each morning the eggs were washed from the toweling and concentrated by filtration. Consequently each lot of eggs could have been on a wet surface for as long as 24 hours before being used in a test.

Except for one test, in which the eggs were not dried, the eggs were alternately dried and then flooded with various media until there was no further hatching. They were placed in small glass vials or on soil samples in 3-inch evaporating dishes for flooding. At the end of each test the unhatched eggs were dissected to determine whether any were still viable. Unless otherwise stated, the unhatched eggs were found to be nonviable when dissected.

TESTS WITH VARIOUS HATCHING MEDIA. The basic hatching media were distilled, rain, tap, and sea water. To these waters were added solutions of asparagine, and infusions of leaves, coke or charcoal, and soil from salt marshes. The leaf infusions were prepared by triturating 1 to 100 grams of green leaves of saltwort, glasswort, or black or white mangrove in 1 liter of water. The asparagine solutions, 2 parts by weight of asparagine to 1 part of sodium biphosphate, were prepared in

[1] Now with Cornell University, Ithaca, New York.

different concentrations. The coke and charcoal were added at the rate of 1 gram to 10 ml., and the soil was added at 0.5 to 1 gram per liter of water.

Eggs to be used in these tests were left on filter paper and placed on sand kept wet with rain water for 6 to 10 days to insure full development of the embryos. The eggs were then stored in glass vials until they were to be used in a test.

Untreated water.—Preliminary tests were made with eggs of *taeniorhynchus, sollicitans,* and *confinnis* that had been wet and dry for various periods of time. Most of these eggs were repeatedly flooded in clean vials with untreated tap water.

Table 1 shows that similar results were obtained with *taeniorhynchus* and *confinnis* eggs, the greatest hatch occurring with the third flooding. Most of the *sollicitans* eggs hatched with the first flooding. More floodings were necessary to hatch eggs of *confinnis* than of either of the other species.

Table 1.—Percentage of eggs hatching with each flooding of untreated water. (120 10-egg samples for all species and 20 additional 50-egg samples for *Aedes taeniorhynchus*)

Flooding	*Aedes taeniorhynchus*	*Aedes sollicitans*	*Psorophora confinnis*
First	0.3	63.8	0.3
Second	12.6	29.7	13.2
Third	84.3	6.5	71.4
Fourth	2.5	0	7.9
Fifth	.3	0	1.0
Sixth	0	—	4.5
Seventh	0	—	1.7

Two viable eggs of *sollicitans* and 11 of *confinnis* hatched in subsequent floodings with asparagine.

Asparagine solutions.—Asparagine at concentrations ranging from 0.001 to 20 percent in distilled water caused 97 to 100 percent hatch of *taeniorhynchus* eggs that had been stored dry for 4 to 8 days (table 2). Little or no difference in the effectiveness of different concentrations of asparagine was shown in tests with lots of eggs that had been stored 4 to 46 days, but with eggs stored for 73 to 83 days fewer eggs hatched in the 0.001 percent solution than in solutions containing more asparagine. There was a marked difference in the percentage hatch of eggs of different ages, the hatch being considerably less for the eggs 73 to 83 days old than for those 26 to 46 days old.

Eggs of *sollicitans* hatched equally well in tap, rain, and distilled water to which asparagine had been added (table 3), but the hatch was lower when this chemical was added to sea water. The lowest hatch with sea water occurred with the highest concentration (2 percent) of asparagine, but there was little difference between hatches at other concentrations. With the other waters fewer eggs hatched with 0.0001 percent of asparagine than with higher concentrations, which gave about equal hatches. The hatch of eggs treated with the 0.0001 percent of asparagine was only slightly different from that of eggs flooded with untreated water. There was no difference in the number of eggs of the same age hatching when flooded with the four test waters containing no asparagine.

When data on the percentages of eggs that hatched with each flooding of asparagine solutions were assembled (not given in the tables), it was found that all eggs of both *Aedes* species hatched with two floodings of asparagine-treated water. The first flooding caused 81 percent of the *sollicitans* eggs and 90 percent of the *taeniorhynchus* eggs to hatch. Most of the eggs that failed to hatch were in solutions containing less than 0.01 percent of asparagine.

Leaf infusions.—Infusions prepared with

TABLE 2.—Percentage of *Aedes taeniorhynchus* eggs hatching in distilled water containing asparagine after being stored dry for different periods. (10 to 30 10-egg samples for each concentration and each storage period.)

Concentration of Asparagine (percent)	4–8 Days	26–46 Days	73–83 Days
20	100	70	24
5	100	70	50
0.1	100	70	45
.01	97	—	35
.001	100	—	10
Untreated water (check)	—	85	58

TABLE 3.—Percentage of *Aedes sollicitans* eggs hatching in asparagine solutions made with different kinds of water

Concentration of Asparagine (percent)	Stored Dry for 133–142 Days; (110 10-Egg Samples)				Stored Dry for 4–42 Days; (45 10-Egg Samples)
	Tap	Sea	Rain	Distilled	Distilled
2	88	2	92	—	86
0.5	88	26	88	86	98
.01	73	32	81	90	100
.001	69	28	82	92	98
.0001	58	42	46	58	84
Untreated water (check)	50	51	52	54	92

black mangrove leaves in tap, distilled, and rain water each gave about the same hatch of *sollicitans* eggs, but the hatches were somewhat smaller than with asparagine solutions. The infusions made with sea water showed almost negligible hatches (table 4). Because the hatching of *taeniorhynchus* paralleled that of *sollicitans*, data on this species are not presented.

When the data on all floodings with leaf infusions were assembled (not shown in tables), it was found that only two of several thousand eggs of *taeniorhynchus* and none of *sollicitans* failed to hatch with two floodings. The first flooding caused 91 percent of the *taeniorhynchus* eggs to hatch. Most of the eggs that failed to hatch were in infusions containing less than 0.01 percent of leaves. Results with leaf infusions of saltwort, glasswort, and white mangrove were almost identical with the data presented for black mangrove.

Coke or charcoal and soil infusions.—Several tests were made in which coke or charcoal was added to the flooding water. In each test soil was added 24 hours after the eggs had been flooded. Water containing softwood charcoal caused no hatching of either *taeniorhynchus* or *sollicitans* eggs until soil was added. The hatches with powdered coke were 25 percent for *taeniorhynchus* and 10 per cent for *sollicitans,* and with hardwood charcoal, 5 percent and 25 percent respectively. Untreated water caused 15 percent of the *taeniorhynchus* and 10 percent of the *sollicitans* eggs to hatch. All remaining eggs hatched when soil was added.

Asparagine solutions with and without soil.—A series of preliminary tests was made in which eggs of *taeniorhynchus* were flooded with asparagine solutions, with and without soil. The results, given in table 5, show no increase in hatch when soil was added to the sea-water solutions and a slight decrease in hatch when added to rain-water solutions. All the hatches were high with one flooding, however,

TABLE 4.—Percentage of *Aedes sollicitans* eggs hatching in infusions of black mangrove leaves made with different kinds of water. (Eggs stored dry 135–147 days; 15 10-egg samples for tap water and 10 for the other waters.)

Leaves per Liter of Water (grams)	Tap	Distilled	Rain	Sea
100	59	52	64	—
5	82	68	36	0
1	75	58	50	8
0.5	72	82	60	2
.1	40	76	48	20
Untreated water (check)	54	53	54	55

TABLE 5.—Percentage of *Aedes taeniorhynchus* eggs hatching in asparagine solutions, with and without soil, made from rain and sea water. (Eggs stored 10–20 days; 5 10-egg samples.)

	Rain Water		Sea Water	
Concentration of Asparagine (percent)	First Flooding	Second Flooding	First Flooding	Second Flooding
0.1	98	0	87	2
.1 plus soil	90	1	87	5
.05	98	2	95	1
.05 plus soil	79	17	97	2
.01	100	0	97	1
.01 plus soil	96	3	96	1
Untreated water (check)	2	81	0	83
Filtrate of soil and untreated water	98	0	94	0

TABLE 6.—Percentage of *Aedes taeniorhynchus* eggs hatching after being placed on soil samples and flooded three times in the laboratory with rain or sea water, alone or with 0.01 percent of asparagine. (30 to 36 10-egg samples in each treatment.)

	Eggs Air-Dry for—	
Hatching Medium	10 Days	63–70 Days
Rain water	53	18
Rain water plus asparagine	71 [1]	14
Sea water	62	11
Sea water plus asparagine	52	9

[1] One viable egg after first flooding.

TABLE 7.—Number of salt-marsh *Aedes* larvae on soil samples and percentage of eggs hatching at each flooding with rain water

Number of Soil Samples	Total Number of Larvae	Percent Hatching at Indicated Flooding				
		First	Second	Third	Fourth	Fifth
1,631	2,559	99	1	—	—	—
3,749	8,124	99	1	+	—	—
474	1,548	92	6.1	1.7	0	—
35	475	90	2.7	5.9	1.7	0

and complete after the second. A filtrate of soil and untreated water caused practically complete hatch with one flooding.

In another series of tests, eggs were placed on soil samples and flooded with rain or sea water, with or without asparagine. As shown in table 6, only one viable egg remained after the first flooding.

FLOODING OF SOIL SAMPLES. Data from soil-sample studies are summarized here to show how many of the eggs hatched with each flooding of rain water. Only rarely were *sollicitans* mosquitoes taken from samples, but *taeniorhynchus* constituted well over 90 percent of the total hatch. Some of the soil samples were flooded from two to five times with a drying period between each flooding, but several series of samples were discarded when no hatching occurred. In most series, however, all samples were flooded three times even though there was no hatching at the second flooding.

Table 7 shows that 90 percent or more of the eggs hatched with the first flooding. However, on the average 98 percent of the eggs that hatched did so with the first flooding.

EFFECT OF DESICCATION ON VIABILITY OF EGGS. Eggs wet and dry for various periods.—Two series of tests were made in which eggs of the three species were subjected to various degrees of desiccation.

In series 1 eggs of *taeniorhynchus* and *confinnis* were placed on squares of wet blotting paper. Half of these squares were placed in a dish to dry, and each day for 10 days one lot of these eggs for each species was placed on wet sand. The other squares were kept on wet sand, but each day for 10 days one lot of eggs for each species was removed from the wet sand and allowed to dry. At the end of the 10-day period all eggs were alternately dried and flooded with one of the four hatching media. Fifty eggs were used for each treatment and the tests were not replicated.

In series 2 *taeniorhynchus* and *sollicitans* eggs were placed on squares of dry blotting paper. These eggs dried immediately, whereas in series 1 the rapidity with which the wet squares became air-dry depended upon the evaporation rate. Six replications with 10 eggs in each treatment were used for each species.

Eggs of the three species were also stored under air-dry and humid conditions. The vials of eggs stored under dry conditions were placed on shelves in the laboratory. The vials of eggs stored under humid conditions were sealed in a large fruit jar with water on the bottom.

Of the eggs on wet blotting paper that were dried slowly, those of *taeniorhynchus* failed to hatch after 3 or more days of drying and those of *confinnis* failed to hatch after 5 or more days (table 8). The exceptions are as follows: One egg of *taeniorhynchus* hatched in the sample dried for 10 days and one egg of *confinnis* hatched in each of the samples dried for 6 or 7 days. Subsequent tests indicated that these unusual records were most likely due to eggs that had stuck to the bottom of the lantern globes and were not removed on the day of oviposition. Thus they had remained wet, and were inadvertently removed with eggs that were recently laid; therefore, they could have been several days old. This chance of error was corrected in the second series of tests, in which no eggs of *taeniorhynchus* or *sollicitans* hatched after even 1 day of drying.

When the eggs of *taeniorhynchus* and *sollicitans* were kept wet for a variable number of days before being dried, only one *taeniorhynchus* (series 1) egg hatched when kept wet only 1 day prior to drying. Many eggs of both species were viable after being wet only 2 days, and 3 days seemed necessary for the embryo to mature properly. Eggs of *sollicitans* seemed less damaged by early drying than did those of *taeniorhynchus*. The eggs of *confinnis* were more resistant to damage from drying than eggs of the salt-marsh species.

Some miscellaneous observations on the effect of age and desiccation on the viability of *taeniorhynchus* and *sollicitans* eggs are summarized in table 9. The data

have been assembled from the hatching-media tests, and are therefore somewhat fragmentary. Since they show rather definite trends, they might be of interest to others who are studying the bionomics of mosquito eggs.

Although only a few of the data in table 9 can be compared, the *taeniorhynchus* eggs appeared to be affected more rapidly by aging under air-dry conditions than did those of *sollicitans*. When eggs of both species were stored in a humidity chamber, they were viable much longer than when kept under air-dry conditions, and again the *taeniorhynchus* eggs were more affected by age.

Eggs of *confinnis* were strikingly more resistant to aging than the other two species kept in dry storage. Data not included in the table showed that 90 percent hatched after 212 days and 80 percent after 240 days of dry storage. No eggs hatched after 329 days of dry storage.

Eggs not dried.—An additional experiment was made to determine whether eggs of salt-marsh *Aedes* would hatch under laboratory conditions without being dried. One lot of *taeniorhynchus* and two lots of *sollicitans* eggs were taken from the oviposition cages, and several hundred of each placed immediately in vials, 1 by 3 inches, which were then filled with distilled, rain, tap, or sea water. All the eggs sank to the bottom of the vials immediately and remained there during the entire experiment. The water containing the *taeniorhynchus* eggs and one lot of the *sollicitans* eggs was stirred periodically. The vials were refilled twice, and samples of the eggs were removed at intervals to determine the percentage that had hatched.

Between the fourth and eighth days after oviposition, a few eggs of both species hatched in all but one of the vials, although the vials had been undisturbed and the eggs had not been dried after the

TABLE 8.—Percentage of mosquito eggs viable after being kept wet and dry for different periods while embryos were forming

Treatment (days)		Series 1		Series 2	
		Aedes taeniorhynchus	*Psorophora confinnis* [1]	*Aedes taeniorhynchus*	*Aedes sollicitans*
Dry	Wet	Eggs Dry During Initial Treatment			
1	9	22	30 (3)	0	0
2	8	12	18	0	0
3	7	6	16	0	0
4	6	0	18	0	0
5	5	0	10	0	0
6	4	0	2	0	0
7	3	0	2	0	0
8	2	0	0	0	0
9	1	0	0	0	0
10	0	2	0	0	0
Wet	Dry	Eggs Wet During Initial Treatment			
1	9	2	56 (2)	0	0
2	8	16	90 (1)	35	76
3	7	50	78	75	93
4	6	64	40 (1)	87	83
5	5	86	32	87	79
6	4	82	46	72	81
7	3	86	38	85	81
8	2	82	34	93	83
9	1	74	42	87	79
10	0	64	68 (4)	70	83

[1] Numbers in parentheses indicate the eggs that did not hatch and were still viable at the end of the experiment.

TABLE 9.—Effect of age and desiccation on the hatching of marsh-mosquito eggs after the embryos are formed. (10-egg samples)

Aedes taeniorhynchus			*Aedes sollicitans*		
Number of Samples	Days Dry	Percent of Eggs Hatching	Number of Samples	Days Dry	Percent of Eggs Hatching
		Stored Under Air-Dry Conditions			
15	4	99	15	4	95
15	6	99	15	6	99
15	8	87	24	16	95
220	10	95	15	21	97
8	26	74	16	22	93
36	45	74	15	36	95
10	46	62	15	42	88
32	73	49	—	—	—
30	83	31	60	133	63
5	196	0	55	135	76
5	203	0	60	136	76
5	205	0	60	137	73
5	207	0	60	138	43
5	284	0	160	142	52
—	—	—	130	147	45
—	—	—	85	159	12
—	—	—	8	171	8
—	—	—	5	198	4
—	—	—	5	199	0
—	—	—	5	204	2
—	—	—	5	207	0
—	—	—	5	237	0
—	—	—	5	243	0
		Stored in Humidity Chamber			
2	196	85	4	169	98
2	204	55	2	196	75
2	345	0	2	204	85
—	—	—	2	345	0

embryos were formed. The only vial in which no eggs hatched was the one containing *taeniorhynchus* and sea water. The next hatchings took place when the water and eggs in the vials were stirred on the 24th day after oviposition when 6 *sollicitans* eggs hatched in the vial flooded with sea water, and on the 142nd day when 4 eggs hatched in the vial flooded with tap water. No other eggs hatched despite additional stirrings until the 210th day, when the vials were refilled with fresh water. Many eggs hatched in all but the one vial containing *taeniorhynchus* eggs covered with sea water. On the 73rd day a sample of eggs was withdrawn with a pipette from each vial to determine how many had hatched. For *taeniorhynchus* the hatch in the distilled, rain, tap, and sea water was 4, 2, 42, and 0, respectively, and for *sollicitans* it was 21, 20, 62, and 17. When water was added on the 327th day, no eggs hatched, and when the eggs were dissected on the 336th day, no viable eggs remained.

The second lot of *sollicitans* eggs was submerged in rain water within 24 hours after oviposition. By the eighth day 8 percent of these eggs had hatched, although the vials had been undisturbed and the eggs had not been dried. The remaining eggs were then divided equally among vials of distilled, rain, tap, and sea water. There was additional hatching after the transfer of the eggs between the 8th and 11th day in all vials but the one containing sea water while the vials were undisturbed, and also when all the vials were refilled

with fresh water on the 19th and 68th days. The addition of fresh water on the 127th day caused hatching in only the rain water. In addition to the hatching in this second lot of eggs, some eggs hatched in all vials when they were stirred on the 51st day; but stirring on the 66th day caused hatching in only the distilled water. On the 123rd day samples were withdrawn to determine how many eggs had hatched. The percentage hatching in the distilled, rain, tap, and sea water was 25, 30, 23, and 22, respectively. On the 192nd day stirring caused some hatch in the rain and distilled water, but not in the tap or sea water. No eggs hatched when water was added to the vials on the 261st day, and there were no viable eggs on the 386th day.

Discussion. A number of workers have studied hatching stimuli for mosquito eggs. These studies, as summarized by Bates (1949), record observations similar to those reported in this paper. Several other workers have made observations on the hatching of mosquito eggs present in soil or plant debris (Dunn 1926, Connell 1940, Filsinger 1940, Bradley and Travis 1942, Travis and Bradley 1943, Horsfall 1949, Wilkins and Breland 1949, Bodman and Gannon 1950, and Buxton and Breland 1952). In most of their work the eggs were hatched by flooding the soil and debris with untreated water or with plant infusions.

Most of the early workers associated hatching stimuli with organic materials. Gjullin *et al.* (1939 and 1941) list several organic chemicals that can cause a reduction of the dissolved oxygen in the flooding media and stimulate hatching. Recently (Abdel-Malek 1948) plant hormones have been shown to stimulate the hatching of *Aedes* eggs.

Regardless of the nature of the various compounds that may be found to be associated with egg-hatching stimuli, it is obvious from the work in this paper and that of others that adequate egg-hatching stimuli are present or will develop quickly in soil and plant debris. It is also shown that eggs of different marsh mosquitoes differ in their resistance to desiccation. The resistance to desiccation of the three test species was in the following order: *confinnis, sollicitans,* and *taeniorhynchus.* It is likely that this order is correlated with the type of environment in which these eggs are normally laid. *P. confinnis* eggs are laid on fresh-water marshes, and such marshes may become much drier than the salt marshes. It is also to be noted that more floodings were necessary to hatch eggs of *confinnis* than of either of the salt-marsh species.

Some of the results obtained in this study cannot now be explained. For instance, why should fewer *sollicitans* eggs be viable when flooded with untreated tap, rain, or distilled water than with those waters treated with asparagine solutions, as summarized in table 3. It should be pointed out again that the hatches as given in the table represent all the viable eggs as confirmed by dissections at the end of the tests. The data seem to show that the viability of eggs not hatching with the first flooding may have been altered by this flooding. Another puzzling point is that the viability of eggs stored for long periods of time was apparently damaged by sea water to which leaf infusions or asparagine solutions were added (tables 3, 4, and 6), whereas eggs stored for shorter periods (tables 5 and 6) seemed to hatch as well in sea water as in rain water in the presence of soil or asparagine. Furthermore, when kept submerged in sea water, the eggs of *taeniorhynchus* were rendered nonviable. This observation is difficult to explain, as *taeniorhynchus* eggs occur on marshes that are periodically flooded with full-strength sea water.

The data presented in this paper are incomplete, as they were not obtained to solve a research problem on hatching. They were obtained in connection with studies to find a means of getting a hatch on soil samples complete enough to use the data in population studies. It is hoped that these preliminary observations will stimulate other workers to make a detailed

study of the biology of marsh-mosquito eggs.

SUMMARY. Laboratory studies were undertaken to develop a method of flooding that would insure a complete hatch of mosquito eggs on soil samples collected from salt marshes for population studies.

When eggs of *Aedes taeniorhynchus* (Wied.), *sollicitans* (Wlkr.), and *Psorophora confinnis* (L.-Arr.) were flooded repeatedly with untreated water in clean vials in the laboratory, they continued to hatch through the fifth, third, and seventh floodings, respectively. The greatest percentage of *taeniorhynchus* and *confinnis* eggs hatched with the third flooding and of *sollicitans* with the first.

The addition of asparagine-sodium biphosphate solutions or infusions made with the leaves of marsh plants or soil to rain, tap, distilled, or sea water caused nearly all the *Aedes* eggs to hatch with the first flooding. The fewest eggs hatched in the treated sea water than in the other waters.

Nearly all the *taeniorhynchus* eggs placed on marsh-soil samples hatched with the first flooding. Fewer eggs hatched in the treated sea water than in the other waters. When eggs of *taeniorhynchus* were placed on marsh-soil samples, nearly all hatched with the first flooding of rain or sea water, with or without asparagine.

The hatching data from soil samples collected from salt marshes and flooded with rain water to determine egg populations showed that more than 90 percent of the *Aedes* eggs hatched with one flooding. A small amount of hatching can be expected with at least four floodings.

Eggs of *taeniorhynchus* and *sollicitans* submerged in rain, tap, or distilled water within 24 hours after being laid hatched without an interval of drying. Some hatching occurred between the 4th to 8th days and thereafter up to the 210th day when fresh water was added or when the eggs were stirred in the containers. Eggs of *sollicitans* hatched in a like manner in sea water, but no *taeniorhynchus* eggs hatched when kept in sea water.

When the eggs of the three test species were kept wet and dry for a variable number of days, many of them were viable after being kept wet for only 2 days, but 3 days seemed necessary for the embryos to properly mature. Eggs of *sollicitans* were less damaged by drying within the first 3 days than those of *taeniorhynchus*, but *confinnis* eggs were the most resistant to damage from drying. The same relationship held for eggs stored in air-dry glass vials.

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EVALUATION OF INSECT PREDATOR-PREY RELATIONSHIPS BY PRECIPITIN TEST STUDIES [1]

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The control of noxious insects by chemical methods has received new impetus in recent years with the advent of the chlorinated hydrocarbons and organic phosphates. It has become evident, however, that these newer insecticides do not furnish panaceas. The development of resistant strains of insects and the destruction not only of the noxious insect but its parasites and predators as well by the use of these insecticides are two recognized conditions.

These developments have served to focus attention on the importance of biological control, although it is generally recognized that natural control agents themselves do not give an absolute form of permanent control.

Entomophagous insects constitute one of the major groups of natural control agents. The assessment of predator effectiveness is frequently difficult. Laboratory trials or field observations may give inconclusive information. New methods of evaluation are being sought continually. Debach (2) has suggested a method for checking the efficacy of entomophagous insects by using a DDT sprayed plot as a check and an untreated plot as the test area. This method obviously would be applicable only in certain environments and requires that the DDT eliminates the predators or parasites while having practically no effect on the host species. Radioisotopes offer an exact means of checking predator feeding habits. However, a limitation is imposed by the necessity of first making the host population radioactive.

The preliminary investigations of Brooke and Proske (1) who used the precipitin test as a method for determining the predators of mosquito larvae and pupae suggested another approach which has been followed in this laboratory. The precipitin test offers a method by which it can be determined what proportion of a sample of predators has fed on a particular host species.

The precipitin test is a well-established serological procedure widely used in many fields of biology and medicine. Its use in entomology has been discussed by West (8). It is commonly used in determining the source of blood-meals of biting flies (Eligh, 3) and systematic serology has been used in the study of certain taxonomic groups such as Orthoptera (Leone, 6, 7). Brooke and Proske (1) furnish the only published reference dealing with the use of the precipitin test for the determination of insect predator-prey relationships. These authors described experiments in which observed or suspected predators of immature stages of mosquitos were macerated in physiological saline and the extract titrated against anti-mosquito sera.

In studies of blood-meals of biting flies it is the usual practice to smear blood-engorged flies on pieces of filter paper. These smears are dried and at a later time are extracted with saline and the extract titrated against suspected host antisera. In the present work this filter paper smear technique has been adapted to the study of insect predator hosts.

MATERIALS AND METHODS. It is not the purpose of this paper to discuss in detail the technical aspects of the precipitin test as used in these studies. During the past

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three years much of the work has been of a developmental nature since the precipitin test is not applicable as a routine procedure. These technical details which have been reported on in part by Hall (5) will be discussed in a later publication. The present paper is concerned with demonstrating the effectiveness of the precipitin test when applied to the study of predator-prey relationships. Methods of study of a reduviid predator (*Zelus exsanguis* (Stahl)) of the forest tent caterpillar (*Malacosoma disstria* Hbn.) are described as an example of the technique used.

Preparation of antigens. The preparation of a cell-free extract used as an antigen was patterned on the procedure described by Leone (6, 7). Forest tent caterpillar larvae, approximately half-grown, were collected and starved for 48 hours to permit emptying of the gut, thus reducing the possibility of contamination from the gut contents. Extraneous material was removed by washing in several changes of distilled water following which the larvae were dried by gently rolling them between paper towels. The larvae were then macerated using a mortar and pestle with the addition of buffered physiological saline (Evans, 4) during grinding. The volume of saline added was equal to the volume of unmacerated larvae. The saline-insect mixture was placed in bottles and refrigerated at 8° C. for 48 hours. At the end of this period the extraction mixture was filtered through a Buchner funnel using negative pressure and "Celite" as aids. The clear filtrate was sterilized by passage through a Seitz filter and was bottled in 20 ml. serum vials. Merthiolate preservative was added to give a final concentration of 1:10,000 and the antigen was stored at 8° C. until required for use.

Production of antisera. Three rabbits were used for the production of antisera against any one antigen. The antigen injection series consisted of an initial dose of 1/4 ml. given intravenously followed on successive days by 1/2, 1 and 2 ml. given subcutaneously. Trial bleedings were made at intervals after 7 days. With the forest tent caterpillar antigen one rabbit showed a titre of 1:12,500 on the fourteenth day and was bled for a supply of antiserum. By administering booster shots at subsequent intervals an adequate supply of anti-forest tent caterpillar larva serum was collected. The titre was determined as the highest dilution of the antigen which gave a positive ring test with a constant dilution of antiserum. Experience showed that titres of at least 1:5,000, using undiluted antiserum, were desirable for predator studies. Antisera were Seitz-filtered and stored in a frozen state at —25° C. until required for use.

Preparation of smears. The predator smear technique used is similar to that used by Eligh (3) and others in studies of blood meals of biting flies. This method permits the collecting and smearing on filter paper of the entire predator or the gut contents of the predator. The smear is placed in an envelope on which pertinent data are recorded. These smears can be stored for an indefinite period. Some of the tests described in this paper were performed with smears which had been stored for two years. Smears of host material for use as positive controls are prepared in the same manner.

Performance of tests. For testing, the smear areas were cut from the filter papers and placed individually in 5 ml. beakers. Two ml. of buffered physiological saline were added to each beaker and the smears were allowed to soak for 4 to 6 hours at 21° C. It is probable that a shorter extraction time would be satisfactory. Following this extraction 0.2 ml. of the extracts were pipetted into serological test-tubes. Two-tenths ml. of anti-forest tent caterpillar serum, whose titre had been checked after thawing, were underlayered in each tube. The tubes were incubated at 37° C. and were read at one and two hours. A positive test was indicated by the appearance of a precipitin "ring" at the interface. In these initial studies all tests were read independently by three observers and any cases of disagreement were called negative. In these particular studies the antiserum was diluted 1:2 with glycerine-saline.

EXPERIMENTAL PROCEDURE AND RESULTS. To demonstrate the effectiveness of the precipitin test, series of "known-feeding" smears were prepared. Adult male and female predators (*Zelus exsanguis,* Reduviidae) were collected in the field and were placed individually in shell vials in the laboratory. Each predator was supplied with a tent caterpillar larva and the feeding time was recorded as closely as possible. Series of smears of predators which were known to have fed on a tent caterpillar were prepared immediately after feeding and at approximately 24-hour intervals over a period of several days. One series of predators was held at room temperature which varied between 18 and 25° C. and a second series was held in an incubator at a constant temperature of 25° C. For negative controls smears were prepared of field collected predators which apparently had not fed recently and were then starved for several days, of predators which had fed on larvae of the linden looper (*Erannis tiliaria* Harr.) and of larvae of the linden looper itself. For positive controls smears of forest tent caterpillar larvae and of the eastern tent caterpillar (*Malacosoma americanum* F.) were prepared.

A number of *Z. exsanguis* collected in an area where the forest tent caterpillar was extremely abundant and where feeding on this host had been observed were smeared as "unknowns."

After an interval of two years these smears were tested using an antiserum which had been stored in a frozen state for approximately 10 months. The results of these tests are summarized as follows:

1. The anti-forest tent caterpillar larva serum gave precipitin rings with extracts of smears of various larval stages of both the forest and eastern tent caterpillars.

2. This antiserum did not react with extracts of smears of linden looper larvae, of smears of reduviids which have been starved at 25° C. for 57 hours or at room temperature for five days, of smears of reduviids which had fed on the linden looper or of a smear of a reduviid which had fed on a scarab beetle.

3. The reactions with "known-feeding" smears are summarized in Table 1. Larger numbers of smears were prepared for the shorter holding periods but were not tested because of the consistently positive results obtained for these shorter periods.

4. Sixty of 118 smears of field collected reduviids prepared as "unknowns" gave precipitin rings. Included in this series were two nymphs, one of which gave a positive reaction. There was no difference between sexes as to proportion of positive tests.

These results suggest that the reduviid

TABLE 1.—Results of precipitin tests on smears of a reduviid predator fed on forest tent caterpillar larvae and held for various intervals

Predators held at 25° C.			Predators held at room temperature		
Holding time after feeding	Precipitin reaction		Holding time after feeding	Precipitin reaction	
	Positive	Negative		Positive	Negative
Not held	2	0	24 hr.	2	0
24–32 hr.	3	0	36 hr.	1	0
48–60 hr.	2	0	48 hr.	2	0
72–76 hr.	2	0	72 hr.	2	0
72–81 hr.	2	0	84 hr.	2	0
72–84 hr.	2	0	96 hr.	2	0
96–108 hr.	8	0	108 hr.	2	0
			132 hr.	2	0
			144 hr.	8	2
			168 hr.	5	1

Z. exsanguis commonly feeds on forest tent caterpillar larvae at least when that host is excessively abundant. Since occasional individuals of the eastern tent caterpillar were present in the area it is possible that some predators had fed on that species although this feeding was never observed in the field. Serologically the forest and eastern tent caterpillar larvae could not be separated since the anti-forest tent caterpillar larva serum reacted to the limit of its titre with an eastern tent caterpillar larva antigen. Such a cross-reaction is to be expected within a genus but could possibly be eliminated if necessary by absorption of antisera.

The second most abundant lepidopterous host in the area was the linden looper. It is demonstrated that no cross-reaction occurs between looper antigen and tent caterpillar antiserum.

It is recognized that in the course of digestion of the tent caterpillar material by the predator the caterpillar antigens would eventually be altered or destroyed and precipitin reactions would no longer occur. The rate at which this alteration or destruction occurs would be a function of temperature. The "known-feeding" tests show that the antiserum can detect the presence of antigens for at least four days at 25° C. or for six to seven days at room temperature. These studies were conducted in a field laboratory where room temperatures differed but little from outdoor temperatures. During the present season studies with individual predators have shown that with few exceptions the predator will feed on a tent caterpillar at least every fourth day and rarely only after five days at room temperature. Thus it is concluded that the serological technique gives an accurate assessment of the proportion of predators which are feeding on the tent caterpillar.

OTHER STUDIES. The precipitin test has been applied to the study of several other predator-prey associations. Brief mention of some of these will serve to demonstrate further the possibilities of this technique.

One of the initial "known-feeding" studies was conducted with a species of megalopteran larva as predator and chironomid larvae as hosts. It was shown that an anti-chironomid serum could detect chironomid antigen in the gut of the predator for as long as four days when the predator larvae were held at water temperatures which varied between 16 and 24° C.

The possible value of cross-reactions was also demonstrated in this study. When the supply of anti-chironomid serum had been exhausted it was found that precipitin reactions would occur between extracts of the majority of the megalopteran predator smears and an anti-mosquito larva serum. It was known that the predators had not fed on mosquito larvae. This anti-serum had a homologous titre of 1:10,000 and a heterologous titre of 1:1,500 with chironomid antigen. Had it been desirable it would have been possible to dilute out this cross-reaction which would be expected to occur because of the close taxonomic relationship of the Culicidae and the Chironomidae. Ordinarily a heterologous combination would not be used if avoidable since except for very close relationships a lower degree of sensitivity would exist.

As part of an extensive study of biting fly biology in the Canadian north [1] investigations in biological control have been conducted. Again it has been possible to demonstrate the possible usefulness of the precipitin test. Smears of known or suspected predators of mosquito larvae have been titrated against an anti-mosquito larva serum. No specific study has yet been conducted but positive reactions have been obtained with extracts of smears of Dytiscid larvae and adults and of at least one species of caddice fly larva. No posi-

[1] These studies have been sponsored by the Defence Research Board of Canada and have been under the direction of the Division of Entomology, Canada Department of Agriculture. The writers are indebted to Dr. C. R. Twinn, Chief, Veterinary and Medical Entomology Unit, and to the Superintendent, Defence Research Northern Laboratory, Ft. Churchill, Manitoba, for cooperation.

tive reactions have been obtained with extracts of smears of snails.

Several species of chaoborines are among the most commonly observed predators of mosquito larvae in the vicinity of Churchill, Manitoba. However, the anti-mosquito larva serum was of no value in assessing smears of chaoborines because of the close taxonomic relationship of the chaoborines and culicines. Extracts of smears of starved chaoborines commonly gave precipitin reactions with the anti-mosquito larva serum. Theoretically a tribe specific antiserum could be prepared by absorption.

A further demonstration of the possible usefulness of the precipitin test in studying predator-prey relationships has been made in connection with studies of the predators of the codling moth (*Carpocapsa pomonella* L.) in Nova Scotia apple orchards. This study is complicated by the fact that in addition to the codling moth (family Tortricidae) a number of species of this and the closely related family Olethreutidae occur. The ugly-nest caterpillar (*Archips cerasivorana* Fitch) is commonly an abundant form. A cross-reaction between anti-codling moth larva serum and ugly-nest caterpillar antigen and the reciprocal cross-reaction have been demonstrated in the laboratory. In the future it is hoped to demonstrate that these cross-reactions can be eliminated by absorption.

Positive reactions have been obtained in "known-feeding" tests using both codling moth and ugly-nest antisera to titrate extracts of smears of four species of coccinellids, one pentatomid, one nabid and two arachnids which had been fed on ugly-nest caterpillars. Positive reactions have also been obtained using an anti-codling moth larva serum to titrate extracts of smears of one species of an ostomid, one pentatomid, one reduviid, one chrysopid and one nabid which had fed on codling moth larvae.

A series of smears of suspected predators of eggs of tortricids and olethreutids were titrated with an anti-codling moth pupa serum. Positive reactions were recorded for all species of predators which included three mirids, one anthocorid and two phloeothripids. The sensitivity of the precipitin test is emphasized by the latter observation that the antigen of the codling moth egg or the egg of another tortricid or olethreutid can be detected in insects as small as predatory thrips using an antiserum prepared by injecting a rabbit with codling moth pupal antigen.

SUMMARY

The studies in this laboratory to date have been mainly developmental and have been concerned with demonstrating the usefulness and limitations of the precipitin test for evaluating insect predator-prey relationships. Considerably more developmental work remains to be done before extensive applied studies can be undertaken.

The advantages and limitations of this technique can be summarized as follows:

1. Considerable difficulty has been experienced in producing regularly satisfactory antisera of high titre and avidity. This problem is one of the main concerns at the present time.

2. The occurrence of cross-reactions constitutes a limitation which may be of importance depending upon the complexity of the particular problem being studied. The elimination of cross-reactions by absorption and dilution processes is being investigated at the present time.

3. The precipitin technique is highly sensitive. It offers a means of determining quantitatively to what extent a predator feeds upon a particular host. At the present time the technique is more applicable to determining the predators of a particular host rather than all the hosts of a particular predator. The latter would require the preparation of antisera for all possible hosts.

4. It is felt that the studies reported in this paper indicate that the technique shows considerable promise and offers a valuable additional method of study of insect predator-prey relationships. The development of such techniques should aid

eventually in a better understanding of the rôle and importance of natural control agents.

ACKNOWLEDGMENTS

The writers are indebted to Dr. G. B. Reed and Dr. J. H. Orr of the Department of Bacteriology, Queen's University, for providing animal house facilities and for valuable suggestions. Particular thanks are due to Dr. R. J. Defalco, Department of Zoology, Rutgers University, for frequent advice and criticism.

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ARTICLES

CONSTRUCTION AND USE OF A SIMPLIFIED WINDOW TRAP FOR INSECTS

C. BROOKE WORTH

In the course of studies on the nocturnal activities of anopheline mosquitoes in the Western Ghats of Mysore State, India, it became desirable to construct a number of window traps. The device here described was designed in the course of studies performed by the Mysore State Health Department in cooperation with the Division of Medicine and Public Health of The Rockefeller Foundation. Because of budgetary limitations, shortage of personnel, and the large number of proposed experiments in distantly separated villages, it was necessary that the traps be sturdy, cheaply and quickly made, easily operated, conveniently transported, and adaptable to any sort of window or other aperture of houses and cattle sheds. After numerous models had been made and tested, the design described below was adopted as a standard.

1. MATERIALS REQUIRED FOR ONE TRAP.—(a) A sheet of thin transparent celluloid, 24″ x 24″. (b) A sheet of light plywood, 3′ x 6′. (c) A small quantity of any sort of 1″ boards that can be cut and drilled. (d) A dozen binding staples, 1½″ long. (e) Six-inch Barraud cage frames. (f) Barraud cage nets.

Barraud cages may be of various sizes, but most commonly they are cubes of 6″ or 12″. They are easily made by soldering or welding metal rods or stiff wires at the eight corners of an imaginary cube, so that a framework representing the 12 edges of the cube results. A net is then prepared by sewing together eight square pieces of 26-mesh bobbinet, each piece having the dimensions of one face of the cube. Tapes are attached at the corners so that the net may be tied within the metal frame. One face of the net is pro-

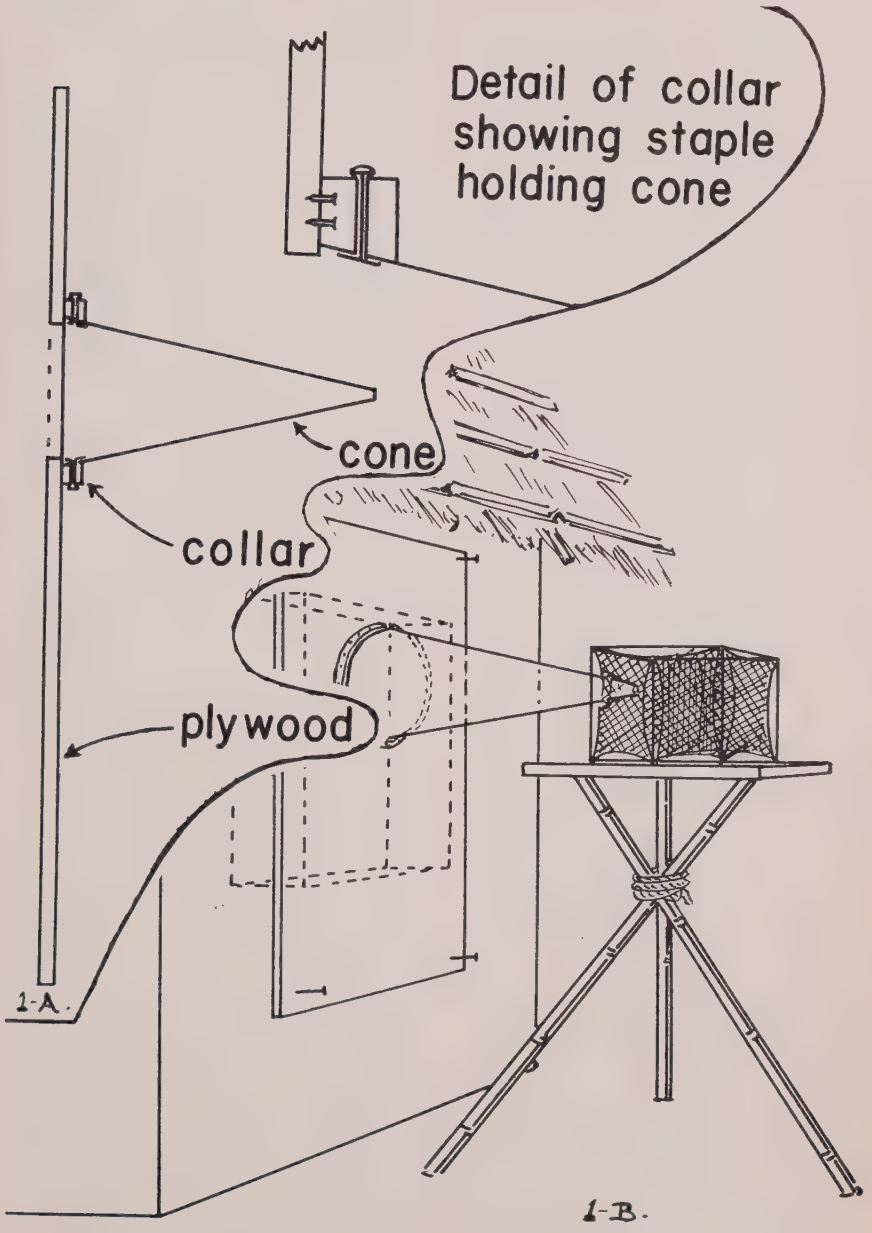

FIG. 1. A. Construction of wooden collar. B. Celluloid funnel trap in position.

vided at its center with a circular collar or sleeve, about 3″ long and 1″ in diameter. This permits the insertion of test tubes or aspirator tubes for introducing or removing insects. The sleeve can be knotted so that the insects do not escape.

Barraud cages are useful for storing or shipping insects. In case of shipment, wooden boxes are built so as to accommodate individual cages snugly. A piece of damp cotton wool is placed on top of each cage to provide moisture in transit.

2. PROCEDURE FOR BUILDING AND SETTING TRAP.—(a) With one corner of the celluloid square as the center, mark off and cut a 90° arc of radius 24″. Trim off the inner corner according to the size of the insects to be caught. Mark off ¼″ or ½″ margins on both sides of the sector and then make perforations at 2″ intervals along the mid-line of these zones, which will eventually overlap. Bend the celluloid into a cone and sew or wire the overlapping edges together through the perforations with heavy thread or light wire. The cone thus produced, if untrimmed at the apex, will have an altitude of 23¼″. Its base is 11.9″ in diameter and just over ¾ sq. ft. in area. The taper is gradual enough so that insects will traverse its length without undue hesitation.

(b) Cut a circular hole, 11.5″ in diameter, in the plywood sheet, with the center of the hole 2′ from one end of the sheet and in the mid-line of its width.

(c) Nail a circular wooden collar, 1″ wide and 1″ thick, around the hole in the plywood, but make the inner diameter of the collar 12″ in extent. This will allow the base of the celluloid cone to impinge against the plywood but also to fit within the collar. The inner surface of the collar may be bevelled to fit the slope of the cone.

(d) Drill a dozen evenly spaced holes radially through the collar; punch corresponding perforations around the base of the celluloid cone; and affix the cone to the collar with the binding staples, (Fig. 1A).

(e) Nail the plywood board across a window or door, with the aperture situated so as to receive maximum illumination from the outside. Seal off all irregularities at the edges of the board by stuffing them with cotton wool, paper, rags, straw, or other litter. If the doorway is large, additional scraps of plywood may be nailed up to complete the blocking of the entrance.

(f) Insert the apex of the cone into the rolled sleeve of a Barraud net so that the open tip of the cone projects into the interior of the net for at least ½″. The Barraud cage may be suspended by wires from outside eaves or it may rest on a platform improvised by piling up boxes, logs, or the like (Fig. 1B).

3. OPERATION OF TRAPS.—During the daytime the Barraud cages should be shaded or frequently changed. Otherwise, houseflies and various Hymenoptera may enter the cages and damage more delicate insects.

At night the cages may be changed according to the time intervals being studied. If mosquito densities are high, the cages should not be allowed to become overcrowded; they should be changed more frequently or else a larger size cage should be used.

4. ADVANTAGES OF THE CELLULOID CONE.—A cone made of window-screen wire was found to trap fewer mosquitoes than the celluloid cone. Furthermore, it was noted that many mosquitoes perched on the wire for some time before entering the cage. Hence the time of ingress into the cage did not correspond to the time that the mosquitoes first attempted to emerge from their shelter. Perching on the smooth celluloid cone is difficult, and entry into the cage is therefore prompt. The chief asset of the celluloid cone, however, is that mosquitoes can be collected directly in the Barraud cages. This eliminates most of the drudgery of night collecting. One man can easily manipulate six or more traps throughout the night, merely changing the cages at desired intervals and labeling them according to the period during which mosquitoes entered.

OBSERVATIONS ON THE CONTINUOUS REARING OF *CULISETA INCIDENS* (THOMSON)

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Introduction. *Culiseta incidens* (Thomson) is a common mosquito in the San Francisco Bay region of California, where it breeds in artificial containers and shaded pools of various kinds throughout most of the year. The potential medical importance of this species as reflected in studies by Hammon and Reeves (1943 and 1943a) and Reeves and Hammon (1946) on the experimental transmission of western equine, St. Louis, and Japanese B encephalitis suggests the desirability of its colonization in the laboratory. This mosquito seems hardy, and the fact that the writer was able to rear it into the third generation under rather adverse conditions suggests that a permanent colony could be maintained under more favorable circumstances. The rearing experiment, which was continued for about 4 months, was done in the apartment of the writer where there were no facilities for controlling such factors as light, temperature, and humidity. The temperature ranged from approximately 55 to 75 degrees Fahrenheit, and the relative humidity was estimated to average 65 percent.

Culture of Immature Stages. The colony was started with third and fourth instar larvae collected in March, 1950, from stream-side pools in Alameda County. Shallow trays of tap water were provided for the larvae and a pinch of finely ground Purina Chow pellets was added to each container at one- or two-day intervals. Dead larvae were removed daily. The water was changed whenever a scum began to develop on the surface.

These same measures were repeated with the F_1 generation, but they proved to be inadequate. Retarded larval growth and a high mortality rate indicated a deficient diet. Following the technique of Frost, Herms, and Hoskins (1936), who successfully reared larvae of this species, the diet was changed to Fleischmann's yeast. An improvement in the health and vigor of the culture was almost immediately apparent. The percentage of survival was several times greater, and larval development was accelerated. The larvae of the F_2 generation were less vigorous and they developed into weak adults. This suggests the need for further nutritional experimentation and better controlled conditions.

Pupae were removed daily from the larval trays and transferred to a container with gradually sloping sides. This vessel was set inside a mosquito cage for the retention of emerging adults.

Care of Adults. The adults emerged in a conventional sleeve-type cage of cloth netting and wood construction, 13 inches high, 14 inches long, and 9 inches wide. Boiled raisins and small wads of cotton soaked with a sugar solution were placed on the netting. Both sexes fed readily. Females of the first generation refused to feed on the writer's arm when it was introduced into the cage, but those of the second generation took human blood quite readily. No evidence of mating activity was observed in either generation when the mosquitoes were in the small cage.

Six days after the emergence of the first adult of the original generation some 150 were released in a dimly lit bathroom 7 feet square and 8½ feet high. Cotton balls soaked with sugar solution were tacked to the walls for nourishment of both sexes. A small black pan filled with tap water to a depth of 2 inches was placed in the shower to receive any eggs that might be laid.

Late in the afternoon of the third day

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after the adults were released in this room, three mosquitoes fed on the writer. From then on a varying number of females fed each day, with a maximum of 24 blood meals being taken in one evening. Several females were observed to feed on a white rat in a small wire cage. However, the movements of the rat were sufficient to discourage most mosquitoes which attempted to feed on it. The mosquitoes would take blood meals only in the late afternoon or at night. The degree of illumination did not seem to influence their readiness to feed, but most feeding was done under artificial light.

MATING HABITS. Eight days after the mosquitoes were released in the room the first mating swarm was observed. Mating occurred nearly every night after this.

A mating swarm could usually be induced to form by turning on the light in the room. On each occasion a few males flew down from the walls and ceiling and began flying in erratic circles close to the floor. Other males later joined the flight and increased the size of the swarm. The swarms observed contained from ten to approximately fifty individuals. The largest swarms covered an area about four feet in diameter and extended from the level of the floor to two feet above it.

Females, apparently attracted by the high-pitched humming, flew into the swarm and were immediately seized in copulation. The copulating pairs became united by the tips of their abdomens and flew horizontally toward one of the walls, the female pulling the male. The female lit on the wall, and the male at times also came to rest momentarily. More often the male made efforts to escape. Finally becoming disengaged, the male usually flew away, leaving the female on the wall.

Other males, apparently fatigued by their courtship flights, were seen to leave the swarm and to rest on the floor or wall. If a mating swarm were left undisturbed, it would gradually decrease in numbers after an hour or so, until only one or two males remained. Swarming could be brought to a halt within a few seconds by merely turning off the light, as indicated by the cessation of the humming sound.

OVIPOSITION. Two egg rafts were discovered in the pan set out for that purpose eight days after the first mating was observed. Thereafter, an average of two rafts per night was laid over a period of a week, after which the breeding pan was removed. A pail containing a little water, which had previously received only one egg raft, then became the site of oviposition. All rafts, except one laid early in the morning, were deposited at night. The eggs took three days to hatch.

The writer was fortunate enough to witness two ovipositions while the light was on. In the first incident, a female was observed to hover above the pan for a time before alighting on the rim. Then it turned around and backed slowly down onto the water. It drifted on the water surface a short distance away from the side and began laying its eggs. In the second case the female was already on the water and had just begun ovipositing. It completed its raft 14 minutes later. The pointed end of the boat-shaped raft is formed first, the last eggs forming the rounded end.

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THE HALTERES OF *ANOPHELES WALKERI* THEOBALD

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A recent training aid manual (Anonymous, 1946) has emphasized the color of the halteres as a means of identifying *Anopheles walkeri* Theobald. The film strip picture points out the "golden halter," the accompanying text refers to the "golden color of the halteres" and the pictorial key says, "halter knob golden yellow." For most of the country this is an excellent character, but when one attempts to determine specimens from states bordering Canada, or from Canada itself, some difficulty is encountered. Specimens recently received from the northern New England states brought this to my attention and led to an examination of more than 300 specimens in the collection of the U. S. National Museum.

The specimens examined were from Arkansas, Delaware, Florida, Georgia, Indiana, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Hampshire, New Jersey, New York, Ontario, Rhode Island, South Carolina, Tennessee, Texas, Virginia, Vermont, and Wisconsin. All had the concentration of dark scales into more or less distinct spots on the wings, the distinct white bands on the palpi, and the pale knee spots characteristic of *walkeri*. Most of them had entirely yellow halteres with pale yellow scales on the knobs. A few had the knobs brownish and the scales distinctly darkened. Data for these latter specimens, with additional comments, are as follow:

Minnesota. Wabasha 1.VIII.40 (Pratt), 2; Detroit Lakes 9.IX.40 (Hoffmann), 1. Specimens collected at Wabasha in late June and early July had yellow halteres, as did specimens from Kellogg, Sept. 25, Winona, Sept. 18, and Weaver, June 28. All of these localities are in the southeastern part of the state in Wabasha and Winona Counties. Detroit Lakes is westcentral.

Wisconsin. Sawyer Co. 12.VIII.41, 1; Vilas Co. 4.VIII.41, 1; Washburn Co., 22.VIII.41, 1. Specimens with yellow halteres came from Grant Co., 9.IX.4, Sheboygan Co., 19.VII.41, and Waubesha Co., 11.VII.41. The specimens with dark halteres all came from the northern part of the state, those with yellow halteres from the southern part.

Michigan. Camp Custer, Battle Creek, 5; Fenton, 12.VII.47 (Obrecht), 2; Gwinn, 26.VIII.33, 1. There were no others from Michigan.

Ontario. Kenora, 2.VII.18 (Dyar), 1; Ottawa, 16–23.VIII.00, 3; Trenton, 26.VI. 11, 1. The scales are rather pale brown, but all of the specimens have faded considerably due to age. There are no other Ontario specimens.

New York. Route 22 to Willsboro, 18.VI.52 (Coher), 1; Ray Brook, 31.VIII. 22 (Shannon & Sibley), 1; Barnum Pond, 31.VIII.33, 1; Bolton Landing, 27.VIII.33, 1; North Fairhaven, 4.VII.20 (Shannon), 5; Ithaca, 4.VII.22 (Matheson), 2, and 1.VIII.22, 2. Specimens with the scales yellow are from North Fairhaven (same series as above), 2, and Ithaca, 20.IX.32, 12. The darker North Fairhaven specimens are still rather pale, which may be due to fading, but two specimens are distinctly yellower than the other five.

Vermont. Williamstown, 16.VI.52, 4; 8 miles north of Williamstown, 16.VI.52, 9; Downer State Forest 21.VII.52, 1 (All Coher). No other specimens from Vermont have been seen.

New Hampshire Center Harbor, 25. VII. and 4.IX. (Dyar), 2. No other specimens from New Hampshire have been seen.

Maine. Sebago Lake State Park

(Kuschke), 2; Rangeley, 29.VIII.33, 1; Augusta, 2.IX.51, 1. Two others from the first locality, and presumably collected at the same time by J. C. Kuschke have the halteres yellow, with yellow scales.

It should be noted that the type locality of *walkeri* is Lake Simcoe, Ontario, Canada and that the original description (Theobald 1901, p. 199) states, "Halteres with ochraceous stem and a large globular dusky knob." Howard, Dyar and Knab (1917, p. 1034), in redescribing the species say, "Halteres brownish." If there is any significance to this difference in the color of the halteres and to the northern distribution of specimens with the darker halteres, it would appear that the typical form is not the one widespread in the United States. This note is presented to stimulate further collecting of the species in the north and careful examination and comparison of eggs, larvae, and pupae to determine what significance there may be in this color variation.

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AEDES (O) *SOLLICITANS* (WALKER) AND *CULISETA* (C) *MORSITANS* (THEOBALD) IN KENTUCKY

THEODORE E. BLAKESLEE [1] AND GEORGE S. PAYNE [2]

Quinby *et al.* (1944) reviewed mosquito distribution records of the forty-two species which had been reported from Kentucky. Kitzmiller (1945) described the collection of an additional species *Orthopodomyia alba* Baker. Carpenter (1952) published collection records of twenty-four species taken during 1944 and 1945 at six military installations located in Kentucky.

This paper includes collection records of two additional species which were taken in Kentucky during 1952.

One female *Aedes* (O) *sollicitans* (Walker) collected June 6, and one female *Culiseta* (C) *morsitans* (Theobald)[3] collected September 30 were taken in light traps at Fort Knox, Kentucky, during the course of routine surveys conducted at that installation. The proximity to Godman Airfield of the location in which the specimen of *A. sollicitans* was collected suggests the possibility of importation by aircraft. However, local breeding in salt water collections from wells or other sources cannot be excluded from attempting to account for the existence of this species in that inland area.

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[3] The authors are indebted to Dr. Alan Stone for confirmation of these specimens.

ASSOCIATION NEWS

DR. F. C. BISHOPP, President of the American Mosquito Control Association, has sent in the names of those whom he has asked to serve on the various committees appointed for the handling of the business of the Association. This list is presented below. Some names are tentative in the sense that acceptances have not yet been received from all those listed, but it is assumed that they will serve in the capacity named.

The following is quoted from Dr. Bishopp's letter:

"I feel certain that all are willing to serve. Some are out of the country temporarily, some are too busy to reply, and no doubt some considered a reply unnecessary. A large number have accepted enthusiastically.

"Some of the committee chairmen have appealed to their committee members and to the Association membership in general for active support. We don't want the committee chairmen to carry the whole load and every committee has a distinct responsibility to do a good job and to bring in a constructive written report at our next annual meeting."

TENTATIVE LIST OF COMMITTEES OF MEMBERS OF THE AMERICAN MOSQUITO CONTROL ASSOCIATION 1953

1. *Standing Committee on Publication of Mosquito News:*

Mr. Richard F. Peters, Chairman, Rt. 3, Box 1763, Springhill Rd., Lafayette, Cal.

Dr. Don M. Rees, Univ. of Utah, Salt Lake City 1, Utah.

Dr. J. H. Williams, Dir. Mosq. Control, Court House Bldg., Sarasota, Fla.

Mr. G. E. Powers, Union Co. Mosq. Exterm. Comm., 324 North Ave. East, Cranford, N. J.

Dr. B. I. Gerry, State Reclamation Board, 41 Tremont St., Boston 33, Mass.

Dr. L. A. Stearns, 278 Orchard Road, Newark, Delaware.

Dr. A. W. A. Brown, Prof. Zoology, Univ. of Western Ontario, London, Ontario, Can.

Mr. Harold Gray, 1A Court House, Oakland 7, Calif.

2. *Standing Committee on Finance:*

Mr. Lester W. Smith, Chairman, Parsonage Road, Metuchen, N. J.

Mr. H. W. Van Hovenberg, Box 288, Mt. Pleasant, Texas.

Mr. H. D. Peters, City Health Dept., 940 Main St., Jacksonville, Fla.

Mr. Herman Fellton, 15 Peachtree Place, N.W., Atlanta, Ga.

Mr. Geo. L. Hutton, Pest Control Section, Bur. of Yards & Docks, Dept. of Navy, Washington 25, D. C.

Mr. Clarence W. Klassen, Ill. Dept. of Public Health, State House, Springfield, Ill.

Mr. Fred H. Stutz, 1909 Dade Co. Court House, Miami, Fla.

Mr. Frank A. Steinrock, TIFA, Todd Shipyard Corp., 81–16 45th Ave., Elmhurst, Queens, N. Y.

Mr. Ted G. Raley, Box 278, Selma, Calif.

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In accord with action taken at the Daytona Beach meeting, I am appointing a committee to consider fully the question of awards for outstanding contributions to mosquito work.

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Com. J. D. DeCoursey, MSC, USN, Naval Med. Field Res. Lab. Marine Barracks, Camp Lejeune, North Carolina.

Dr. R. B. Eads, Texas St. Dept. of Health, Austin 2, Tex.

Miss Helen Louise Trembley, Editor of Reviews Mosq. News, c/o Nat. Inst. of Health, Bethesda 14, Md.

Mr. A. W. Morrill, Jr., Engineering Res. & Development Lab., Ft. Belvoir, Va.

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Dr. W. E. Bickley, Dept. of Entomology, Univ. of Maryland, College Park, Md.—Central-east.

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Mr. Earle D. Potter, Burlington County Mosq. Exterm. Comm., County Office Building, Mount Holly, New Jersey.

Mr. Richard F. Peters, Rt. 3, Box 1763, Springhill Road, Lafayette, California.

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IN MEMORIAM

DEED CLEVELAND THURMAN, JR.

1921–1953

Deed C. Thurman, Jr., died suddenly in Chiengmai, Thailand, April 18, 1953 (Mosquito News, June, 1953, page 167). At the time of his death, he was serving as Malaria Control Advisor for the Northern Region of Thailand, assigned by the United States Public Health Service to the Mutual Security Administration. Both Christian and Buddhist funeral ceremonies were conducted in Thailand.

Captain Thurman majored in entomology at Texas A. and M., and received his Bachelor's degree in Agriculture in 1942. He worked for the State Health Department of Texas from 1942 until 1944 when he was commissioned an officer in the U. S. Public Health Service. He was first assigned to the Office of Malaria Control in War Areas, later, the Communicable Disease Center, where his duties took him from Oklahoma to Georgia, and finally to Florida. In 1949, he was transferred to California, to take charge of the Central Valley Mosquito Control Ecology studies in Turlock. In the same year, he received his degree of Master of Public Health from the University of California.

Modesty, diligence, patience, friendliness, and keen insight, plus a genuine zest for living, endeared him to his fellow workers.

Captain Thurman was assigned the most difficult task confronting California mosquito control, that of studying and devising economic mosquito control measures for the rapidly expanding irrigated pasture problem with its vast *Aedes nigromaculis, A. dorsalis,* and *Culex tarsalis* production. The zeal and thoroughness of his application to the task and the soundness of his plans for investigating the problem, remain as a tribute to his biological genius. Today, the plan, conceived largely by him is progressing effectively in the hands of competent former associates who were inspired by his leadership. His work gave rise to the State's Vector Control Field Station, which is devoted to investigation of California vector problems.

Captain Thurman left the United States for Thailand in March, 1951, and was joined approximately two months later by his wife, Ernestine, also a tireless worker in entomology, and his five-month old daughter. The accomplishments of this family and the esteem in which he was held by his Thai workers was attested to in the numerous letters of condolence at the time of his death, and exemplified in the note contributed below by Dr. Udaya Sandhinand, his closest Thai associate during those two years.

In addition to his wife, Captain Thurman is survived by a daughter, Phyllis, a son, Charles, by

a previous marriage, his parents and a sister.

He published over forty papers dealing with insects of medical importance, their epidemiology, disease transmission, and control. He was a member of numerous scientific societies, including the American Mosquito Control Association, American Association of Economic Entomologists, Entomological Society of America, California Mosquito Control Association, Florida Anti-Mosquito Association, Research Society of America, American Public Health Association, American Society of Parasitologists, American Society of Tropical Medicine and Hygiene, and two scientific groups in Thailand—Richard F. Peters and Helen Louise Trembley.

* * * * * *

Dr. Udaya Sandhinand, one of Captain Thurman's associates in Thailand, writes as follows:

Among the Americans who contributed to the success of the Mutual Security Agency, both technically and diplomatically, in the free countries of Southeast Asia, especially in Thailand, the late Deed C. Thurman, Jr., is very possibly in the topmost group. . . .

His personality, efficiency, and intelligence soon won the confidence of the local members of the malaria control staff. Through his efforts, and those of other Americans, the technical assistance from the MSA for Thailand has resulted in the greatest extension in the malaria control activities in the history of public health in Thailand by covering six provinces in the northern region, and protecting a population of over 2,000,000 within the third year of assistance. . . .

Captain Thurman disclosed that not less than 134 species of mosquitoes are found in northern Thailand. . . . His work in Thailand for the Thai people will live long and remain forever in their memories.

—UDAYA SANDHINAND, M.D.,
Chief Malaria Control Officer,
Northern Provinces, Chiengmai, Thailand

J. LYELL CLARKE

J. Lyell Clarke, sanitary engineer, in charge of all work for DesPlaines Valley Mosquito Abatement District, Lyons, Illinois, for twenty-seven years, died on May 5, 1953, aged 64 years. His unexpected death ended a distinguished career in his profession and forty years of service in federal, state, and district work of benefit both to the Armed Forces and to a large civilian population. He had gained a national reputation, and was one of the leading spirits in the American Mosquito Control Association.

In addition to his professional interests, he was a popular citizen of Riverside, Illinois, and a member of the Izaak Walton League and other societies designed to promote the common good. His sudden death brought expressions of regret and sympathy from professional associates in all parts of the country.

Mr. Clarke was a native of Richmond, Virginia, and born in a family distinguished in that state for generations. He studied at Virginia Polytechnic Institute and Johns Hopkins University. Early in his career he was a partner in the Richmond engineering firm of Bolton, Clarke, and Pratt.

During World War I he was attached to the Army as a member of the U. S. Public Health Service and assigned to mosquito control duties to protect troops. After the war he remained in the service to do research work with the Italian government and for the United States government in Mississippi. Later, he was engaged by Illinois state officials and the International Health Board to aid in the control of mosquitoes in the southern parts of Illinois.

He was employed by DesPlaines District officials in 1928 to organize abatement measures in the midst of an intolerable mosquito annoyance and potential menace to health. In this he was immensely successful according to officials of the District and of twenty-six municipalities within its boundaries, which comprised a population, in 1953, of 234,000 persons. His study of mosquito flight range by means of powdered dyes is considered one of the outstanding pieces of research in its field. This study and others were reported in news dispatches, articles in *Life, Saturday Evening Post, Popular Mechanics,* and radio. Diligent in keeping up with all developments in his field, he was relied upon by his professional colleagues to add to the knowledge necessary to meet the insect problems that vex and menace all the world.

He and others suspected the mosquito of being the vector of polio. Out of this developed long experiments arranged by Mr. Clarke with Yale University and the Chicago Health Department. No evidence was found to convict the mosquito, but the insect is still suspected in some quarters.

Mr. Clarke was a member of the American Society of Civil Engineers, Western Society of Engineers and the Masonic Lodge.

Members of the Board of Trustees of DesPlaines District share with his family and close friends the loss of so competent a leader.—OTTO MCFEELY

NEWS AND NOTES

THE GALVESTON COUNTY MOSQUITO ASSOCIATION was organized at a meeting attended by about 60 representatives of city and county health agencies, leaders of civic and educational associations and various industries held in Galveston, Texas, July 29, 1953.

Dr. Carl Nau, Chairman of the department of public health and preventive medicine of the University of Texas School of Medicine was elected president and empowered to organize various committees.

The main purpose of the organization is to set up a mosquito control district and bring about more effective mosquito control in Galveston county.

AMCA president, F. C. Bishopp, attended the meeting and discussed advantages to be gained by a properly organized and financed anti-mosquito association and some of the problems to be overcome. Mr. William Cox, mosquito control officer of the City Board of Health, presided at the meeting and also gave Dr. Bishopp opportunity to see some of the mosquito problems with which he has been dealing.

DR. WILLIAM E. BICKLEY TAUGHT A COURSE IN ENTOMOLOGY at the Mountain Lake Biological Station of the University of Virginia, Mountain Lake, Virginia, during June and July. There were no mosquito problems although several species were collected. A few blackflies were troublesome occasionally and once in a while *Culicoides* were rather annoying. This station is at an elevation of 3800 feet. Several visiting scientists gave lectures. Among those was Dr. Donald L. Augustine, Head of the Department of Comparative Pathology and Tropical Medicine of the Harvard School of Public Health. Having recently served as a consultant, he reported on some public health work at an American jute mill twenty miles south of Calcutta, India, at the town of Ludlow. The malaria vector is *Anopheles sundaicus* which breeds in mangrove salt marshes. A reduction in the large number of malaria cases was brought about through the use of DDT residual sprays and the newer drugs.

HERBERT T. DALMAT RECENTLY RETURNED FROM GUATEMALA where he has been active in research and control work dealing with black flies in relation to the transmission of onchocerciasis, under the auspices of the Public Health Service and the Pan American Sanitary Bureau. Mr. Dalmat is now on duty at the Laboratory of Tropical Diseases, National Micro-biological Institute, National Institutes of Health, Bethesda, Maryland. He is completing a monograph on the Simuliidae of Guatemala.

CAPT. FRANK G. FAVORITE HAS RECENTLY WRITTEN FROM KOREA where he is actively engaged in insect control activities with emphasis on mosquitoes. His address is Capt. Frank G. Favorite 065989, Med. Sec. Hqs. 8th U. S. Army, APO 301 c/o P.M., San Francisco, California.

DR. HERBERT KNUTSON, FORMERLY HEAD OF THE DEPARTMENT OF ZOOLOGY at the University of Rhode Island, has been named head of the Department of Entomology at Kansas State College, Manhattan, Kansas. He succeeds Dr. Roger C. Smith who will devote full time to research. Dr. Knutson attended Iowa Wesleyan College and did graduate work at Southern Methodist University and the University of Minnesota. He has been actively engaged in mosquito work for a number of years. As an officer in the Public Health Service Malaria Control in War Areas Organization from 1943 to 1946 he held several important assignments. He was formerly administrator of the Division of Entomology and Plant Industry of the Rhode Island Department of Agriculture and Conservation.

DR. DON PLETSCH HAS RECENTLY WRITTEN TO HARRY STAGE as follows: You might be interested in a brief coverage of our progress to date. Following residual spraying treatment in 1952 of the houses of 156,000 people, the results justified expansion of the 1953 coverage to protect 1,503,000 people. The spraying of our central-western and northern Taiwan areas is completed, with spraying of the east coast starting next week. Operations in the south will start in August. Fortunately the variation in transmission season permits the non-simultaneous operations in the several regions. Our 1954 plans are being made for direct protection of 5,000,000 people, or all of the malarious areas in Taiwan. The 1955 operations will repeat the 1954 coverage. We find ourselves quite busy, but not too busy for surveys of *Aedes aegypti* and *albopictus* in airport and seaport cities, plus non-anopheline collections in many areas. Cordially D. J. Pletsch, The W.H.O. Malaria and Insect Control Team (MSA-China), APO 63, c/o P.M., San Francisco, California.

EXCERPT FROM A LETTER TO THE EDITOR OF *Mosquito News* FROM GEORGE J. BURTON: This is quite an experience. I am in a hyperendemic area in which practically every member of the 20,000 population of Monrovia has had malaria, over 80 percent of which is of the *falciparum* kind. The symptoms are quite different from what you find in textbooks, and I have found that the best thing to do here is to throw the books away and base my decisions on what I see before me. Instead of chills and fever, most of the adults have an intense headache, sniffles, perhaps stomach upsets, and general malaise. Many of the white people here have also had malaria, in spite of constant and continued chloroquine therapy, as the parasite breaks through the chloroquine. I have been knee deep and head high in malaria mosquitoes, infected ones at that,

but have not come down with anything. I have been taking Daraprim as well as chloroquine, and have not come down with anything yet. I have awakened in the morning to find engorged female malaria mosquitoes, *Anopheles gambiae* var. *melas* in my room, regardless of screens. These adults vary in size, strangely enough, and I have a hunch some of the smaller ones can squeeze through 18 mesh screening. Will have to investigate the problem further.

There are over 90,000 acres of mangrove swamp, almost all of which is inaccessible, in which the vector is breeding. Gosh knows how many other of the anophelines are vectors also. Filariasis is in the area also, all the vectors not being known, but we believe that the malaria vector is one of the filariasis vectors. Yaws, tropical ulcers, schistosomiasis, leprosy, tuberculosis, trypanosomiasis, etc., are also present. Epidermal fungi drive me nuts at times. Out of a clear sky I begin to itch, and after eliminating the possibility of mites, I apply a fungicide and obtain relief. The temperature is at least 85 most of the time, and the humidity also about 85, so that at times I feel as if I'm living in a tropical greenhouse. My clothes are constantly soaked with perspiration, necessitating a daily change.

We are going to do a spleen index survey, a parasitemia survey, followed by house-to-house residual spraying, using varying dosages of DDT and Dieldrin. We are placing great faith in the Dieldrin, and hope the results will be favorable. There are various kinds of surfaces to spray: reed mat, mud, and cement. The first two are tricky. Former trials with DDT have resulted in oxidation and instability of the chemical, the previous runs being once a month, with poor control of vectors. Well, this experience in the African tropics is the most unusual I have ever had, and wouldn't trade it for any other right now. Sincerely, George J. Burton, TCA Mission to Liberia, American Embassy, Monrovia Liberia, West Africa.

CONCERNING MOSQUITOES FOUND AT CONSIDERABLE DISTANCES OFF-SHORE from Miami Beach, John Mahony writes as follows to Fred Stutz: On Saturday, June 13, 1953, a party of us went fishing in the Gulf Stream on the cruiser "Coline," Capt. A. M. McWilliams, 7171 S.W. 5th Terrace, Miami. With him was a crew of two, whose names I do not know. The boat is owned by Mr. George Collier, of Cat Cay and Wilmington, Delaware, who was not aboard. Our party consisted of Mr. Robert M. Altemus, 8840 Colony Road, South Miami, his guest; an Eastern Airlines pilot (whose name I have forgotten); Mr. Tom McBroom, Jr., 140 N.E. 1st Avenue, Miami, and myself.

We left the dock in the Miami River about 8:30 A.M. and reached the edge of the Gulf Stream about an hour later, the boat being very fast. Sky clear, sea smooth, weather sultry and a very gentle SE or SSE breeze, so gentle as to be negligible. There were no mosquitoes whatever at the dock or in the Miami River when we left.

Fishing became slow, so we headed further off shore, running at trolling speed. About 11:30 A.M. we noticed what appeared to be a haze over the water extending possibly 3 to 5 miles, in a general N–S direction and approximately 10–12 miles off shore—it may have been 15; anyway, the skyline of Miami Beach was beginning to disappear.

We headed into the haze due E from Miami and found it to be a tremendous flight of mosquitoes, the stupid smudgy kind that bite as soon as they hit. They were very bad. The haze, which we ran through, was approximately one mile wide. As all of us are relatively old-time Florida residents and have had considerable experience in the Gulf Stream, we discussed the phenomenon, particularly in view of the fact that the prevailing wind for several days previously had been gentle to moderate SE. Under the circumstances, it seemed most unlikely that the swarm could have originated either in the Everglades or the Florida Keys, nor, for the same reason, either in Bimini or Cat Cay. To the best of my recollection, we were in the swarm for about 45 minutes before we pulled westward to get out of them.

This was my first experience of this nature, but later, in discussing it at the Rod and Reel Club and with some of the professional fishing guides at Miami Beach, I was informed that, while it is most unusual, nevertheless, it has been known to occur in other years in these waters.

Should you desire verification of this data, you might contact the parties named. I will not let them know about this letter so you can get their own versions. Sincerely, John Mahony (Ring, Mahony and Abner), Miami, Florida.

NEWS FROM THE BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE: Dr. Edward F. Knipling has succeeded Dr. Bishopp as Assistant Chief of the Bureau of Entomology and Plant Quarantine in charge of research. He has been with the Bureau since 1930 and was in charge of the Orlando Laboratory during World War II. Many honors have come his way, among which are the United States of America Typhus Commission Medal and His Majesty's medal for service in the Cause of Freedom awarded by Great Britain. Dr. Knipling is also known to A.M.C.A. members as editor of Bulletin No. 2.

Dr. Arthur W. Lindquist succeeds Dr. Knipling as Head of the Division of Insects Affecting Man and Animals. He joined the Bureau in 1931 and since 1947 he has been in charge of the Laboratory at Corvallis, Oregon. Some of the pioneer work on DDT residual sprays against mosquitoes was carried out by Dr. Lindquist at the Orlando Laboratory during the war years. Dr. Lindquist was recently honored by his alma mater, Bethany College, Lindsborg, Kansas, where he received the honorary degree of Doctor of Science. He is a frequent contributor to *Mosquito News*.

HARRY H. STAGE left in mid-August to attend the meetings of the Fifth International Congresses of Tropical Medicine and Malaria in Istanbul,

Turkey. He traveled in Italy, France and Turkey and visited mosquito workers in those areas. Mr. Stage was the official delegate of the A.M.C.A. at the International Congresses.

IN ESSEX COUNTY, NEW JERSEY, Mr. Maximilian M. Stallman retired from the Mosquito Extermination Commission and was succeeded by Mr. Ralph Gates. Word has just been received of the death in July of Mr. George W. Eager who was superintendent of the Commission for many years. Further details will be given in a subsequent number of the *News*.

DR. REECE I. SAILER AND CAPT. ARTHUR REGNIER (Medical Service Corps of the U. S. Army) spent most of June and July in Alaska where they made observations on mosquito populations and abundance in relation to weather conditions. They were especially interested in accumulated precipitation data. In general, mosquito populations were at a low level. The work was supported in part by the Arctic Institute of North America.

A LETTER FROM MISS HELEN LOUISE TREMBLEY informs us that Mrs. Ernestine Thurman, as a memorial to her late husband, Capt. D. C. Thurman, has given a check to the Good Neighbor Club for $26.00, to be used for sending 13 copies of the proposed *Bulletin No. 3* to designated groups in Thailand. The Good Neighbor Club and the AMCA are very grateful for this thoughtful and generous contribution.

REMEMBER: THE ANNUAL MEETING OF THE AMCA is to be held jointly with the annual meeting of the New Jersey Mosquito Extermination Association March 8–12, 1954, Atlantic City, N. J.

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REVIEWS AND ABSTRACTS

The Sardinian Project—an Experiment in Malaria Control by Species Eradication. John A. Logan. Proc. of the Institution of Civil Engineers, (London) April 1953, 14 pp. The author explains that the Sardinian Project was suggested as an application of modern scientific information on a large-scale experimental basis. It was planned to eradicate *Anopheles labranchiae* on the second largest island in the Mediterranean having an area of over 9,000 square miles and a population of 1,250,000. This rough and primitive land includes large areas not served by roads nor railways and is given over to large coastal flats fringed with swamps of brackish or salt-water and shallow, irregular rivers choked with vegetation. The problem was complicated with small blockage, and flooding is widely practiced. In spite of many almost insurmountable problems, malaria as a public health problem was eliminated, but *labranchiae* was not. On October 1, 1945, the International Health Division of the Rockefeller Foundation agreed to assume technical direction of the project which was first suggested and financed to a considerable extent by UNRRA, the United Nations Relief and Rehabilitation Administration and later by ECA, the Economic Cooperation Administration. The cost of the project amounted to more than six billion lire and was active for more than 4½ years. Some idea may be gained of the reduction in numbers of this mosquito when after 5 years of control it took more than 330 scout-days to find a single *labranchiae* infestation. From the evidence presented it was evident that the indigenous *labranchiae* has a whole series of survival characteristics which have been developed over many thousands of years and that these normally make them much more difficult to eradicate than an imported species, such as for example, *A. gambiae* in South America.—H. H. Stage.

Exchanges of Sodium and Potassium in Mosquito Larvae. By Ramsay, J. A. J. Exp. Biol. 30(1):79–89. 1953. This paper is a continuation of the interesting work on osmo-regulation in *Aedes aegypti* larvae. The anal gills of mosquito larvae (which are the only parts of the integument normally permeable to water) can secrete chloride into the hemolymph from the external medium against a gradient. It was shown earlier by the above author that the hypotonic Malpighian tubule fluid was partly reabsorbed into the hemolymph after first passing up the midgut into the gastric caeca and was partly eliminated via the rectum.

The present work shows that while amounts of Na and K in the hemolymph remain relatively constant in spite of considerable changes of these ions the hemolymph still reflects to a limited extent the external changes. The Na:K ratio of whole normal larvae is 2.5:1, that of the hemolymph *ca.* 25:1. It is assumed by the author that Na is only in the hemolymph and the potassium largely held in the tissues. It is clear from this study and others by the same investigator that the anal gills are concerned with the uptake of Na and K, secreting them into the hemolymph. These two ions leave the body via the hindgut. They can be absorbed from the rectum against a gradient back into the hemolymph. Ramsay found that the concentration of K in the intestinal fluid is greater than the Na irrespective of the composition of the external medium.

One of the most interesting of Ramsay's experiments was to inject a larva with hemolymph collected from 5 others and by application of pressure or suction cause stretching or collapse of the larval body. When the larvae were thus stretched the number of droplets passing down the gut was increased over the normal condition. He felt that this was sufficient for concluding that the body volume of the larva is regulated by a simple nervous mechanism. From the observation that gut peristalses of *Aedes* ceased after its removal from the body he infers that gut peristalses are ". . . initiated and probably coordinated by the central nervous system." Finally he writes "increase in the volume of the haemolymph . . . initiates peristalsis" of the gut. Whether he is justified in these statements would appear to require considerably more evidence than is presented.—Jack Colvard Jones.

Map of the World Distribution of Malaria Vectors. May, Jacques M., 1951. Geographical Review, 41(4):638–639, with map. The writer of this paper, who also prepared the accompanying map, is head of the Department of Medical Geography of the American Geographical Society. Dr. May apparently drew many of his distribution records of *Anopheles* from out-dated publications, such as that of Kumm (1929), for in several respects the information given is erroneous. The reviewer does not claim personal knowledge of the anopheline vectors outside of the neotropical region, but he notes the inclusion of such species as *A. aquasalis* in northern Argentina, where it is absent (the species is probably *noroestensis* Galvão & Lane). No mention of its presence in Trinidad is made, but Senior-White considers it to be a coastal vector in that island. It is said to range northward into Nicaragua, but is not present much beyond northeast Panama. *A. albimanus* is shown as present in far eastern Venezuela, at the mouths of the Orinoco, and in Dutch Guiana, but it is not found in either locality. *A. darlingi*, the most important vector in South America, avoids water with the least trace of salt, an important matter which is not noted. So far as the reviewer is aware, this species is not present in northern Yucatan or in southwest Mexico, west coastal Guatemala, or northern Nicaragua. The larvae are often found in full sunlight, not in "shade."

In Saudi Arabia, *A. pharoensis* is shown as

present all over the country, but actually it is scarce or absent there; it is found in Iran. The legend at the upper-righthand corner of the map states: "No [species] symbols are shown for deserts." Much of Saudi Arabia is desert, particularly in the south.

In Thailand (named Siam on the maps) *A. minimus* is the principal vector, but this is not indicated. In the Philippines, *A. minimus flavirostris* is considered the primary vector, but this also is not indicated. *A. aconitus* is indcated on the inset of species "locally distributed over southern Asia and Indonesia," but it is not believed to be a vector in Thailand.

In the "Resumé of Natural History" insct in the upper right-hand corner of the sheet, the peculiar statement is made that the larva of *A. bellator* is found in "holes of bromeliads." Actually, the water in which the larvae breed is held in the rosette-like leaf bases of arboricolous bromeliads. The type of water mentioned for *A.* (*Kerteszia*) *cruzii* is "stagnant, fresh," which is true, but it is not stated that this water is held in the leaf bases of bromeliads, the same habitat in which *bellator* larvae are found. Neither *A. bellator* or *A. cruzii* should be considered "extensively distributed," as the first is found in Trinidad and southern Brazil, and the second has a restricted distribution in southern Brazil, where it may be locally common.

Some egregious errors concerning the distribution of species of malaria parasites are to be found on the map at the bottom center of the sheet. The reviewer has had extensive experience in malaria surveys in Panama and Central America, and takes issue with the indications that *Plasmodium vivax* is the predominant species in Panama. *P. falciparum* and *P. vivax* occurred in most of Panama in a ratio of 70 to 30. In Haiti, where the reviewer assisted in the examination of over 6,000 adult males, *P. malariae* was found in about 25 per cent of all positives. The presence of *P. malariae* in the intermountain valleys of Bolivia is not noted.

A dotted red line on the largest map shows the "approximate limit of Anophelism without malaria," but this statement should be qualified, as the line represents the *southern limit.* A similar line should be shown for the Southern Hemisphere, as anophelism without malaria exists in Chile, southern Argentina, and Uruguay, and doubtless also in South Africa.

It is unfortunate that the author did not consult with authorities on the various subjects covered in his article and accompanying map, as he would have received authentic and up-to-date information. His article on page 638 is correct, with the exception of the statement that "malaria exists wherever malaria vectors are found except in the Northern Hemisphere zone indicated as having anophelism without malaria." South America has similar zones, and presumably also South Africa.—W. H. W. Komp.

NOTES ON IRANIAN MOSQUITOES. R. P. DOW. Amer. J. Trop. Med. Hyg. 2(4):683–695. 1953. In collecting adult mosquitoes, it was an easy matter to sample the populations occurring in the vicinity of man. Most Iranians, especially in the rural areas, live in similar mud-walled houses in close association with their domestic animals. Sometimes, the living quarters are in a story above the stables, but generally both are reached from a common courtyard. Moreover, in the arid parts of Iran, the typical village is so compact and the streets and alleys so bare of shade that there are few spaces other than man-made shelters which are suitable for those mosquitoes that rest in dark places during the day.

Throughout the Caspian Region and Azerbaijan, the procedure in inspecting villages was sufficiently uniform to permit some quantitative as well as qualitative comparison of the different areas. When there was not enough time to make a thorough search of all the roofed space used by one family, it was customary to inspect a minimum of one room and one stable or other animal shelter in each home visited. Though females of the *A. maculipennis* group (and also of *A. superpictus*) were quite generally less common in rooms occupied by man, eggs of *A. sacharovi* typical *A. maculipennis,* and *A. subalpinus* were laid by specimens caught there as well as in stables. It is well known, of course, that the diurnal resting habitats of *Anopheles* are not necessarily the places where they feed. Actually, in this day of controlling malaria by residual insecticides, the important point to determine is whether the types of man-made shelter which can be readily and safely sprayed are also the usual resting places of the principal vectors.

On various kinds of evidence, the important vectors of human malaria in western Iran, both known and probable, can be limited to the following species: *A. sacharovi, A. maculipennis, A. superpictus, A. stephensi,* and *A. culicifacies.* Since each of these as shown in Table 1 and confirmed by other observers, has been found resting in man-made shelters, the second question is, to what extent does the adult population of each species rest in buildings. In the dry regions of Azerbaijan and the Central Plateau, the lack of other daytime habitats appears to concentrate *A. superpictus* as well as *A. sacharovi* and *A. maculipennis* in the villages. Probably *A. superpictus* is a partially wild species in the moist Caspian lowlands (where only one specimen was found in a home). In fact, one of the observations on this behavior by Macan (1950, pp. 202–203) was duplicated by the writer at Klayebon where a rocky stream in which the larvae of *A. superpictus* were abundant was within a few yards of houses from which he did not obtain a single adult. Since *A. sacharovi* and *A. maculipennis* are more abundant in the Caspian Region and of definite house-frequenting habits, the control of *A. superpictus* by indoor residuals may never present a real difficulty.

In southwestern Iran, the problems of malaria control are more circumstantial. Fortunately *A.*

stephensi, of great importance at Abadan, appears to rest commonly in ordinary buildings, but at Bushehr, adult *A. culicifacies* was taken only in the large covered cisterns where the winter rains are collected and stored for use during the dry season. Since they are dark, cool, and not adequately screened, they provide ideal breeding and resting places in which spraying with a toxic insecticide would be most inadvisable. When this minor difficulty has been resolved, perhaps by an engineer, there appears to be no entomological obstacle, other than the behavior of *A. superpictus* in humid areas, to the final control of malaria in western Iran.—Author's discussion.

THE CUTANEOUS REACTION TO THE BITE OF THE MOSQUITO, AEDES AEGYPTI (L.) AND ITS ALLEVIATION BY THE TOPICAL APPLICATION OF AN ANTIHISTAMINIC CREAM (PYRIBENZAMINE). F. J. O'Rourke and M. F. Murnaghan. Journal of Allergy, Vol. 24, No. 2, 120–125, 9 refs. The reactions of 36 medical students to the bites of *Aedes aegypti* mosquitoes are described. These workers found that an antihistaminic cream containing 2 percent Pyribenzamine reduced the severity of irritation following bites from this mosquito. Secondary infections following scratching mosquito bites was considerably reduced.—H. H. Stage.

We trust that our membership read under the "Reviews and Abstracts" in the June issue of *Mosquito News,* the report of the Expert Committee on Insecticides WHO. The fourth paragraph defines the particle size ranges for coarse sprays to aerosols.

It is with a great deal of satisfaction we note that the definitions this Committee set forth are identical with those published on page 15 of the Association's *Bulletin No. 2,* "Ground Equipment and Insecticides for Mosquito Control," that preceded the WHO report by some ten months.

This is a real "First" for our Association and the editors of *Bulletin No. 2* are to be congratulated.

ROBERT L. VANNOTE

MALE SPECIMENS OF THE CULEX PIPIENS COMPLEX (*C. pipiens,* "C. molestus," or *C. fatigans* [=*quinquefasciatus*]) are needed for a study to determine to what extent these forms hybridize in the field. A series of 30 or more males of any of these forms from any locality would be appreciated. The specimens may be in alcohol, pill-boxes, or on pins.—A. R. Barr, Dept. of Entomology, Univ. of Minnesota, University Farm, St. Paul 1, Minn.

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